The British Mycological Society

(*Recognosce notum, ignotum inspice*)

TRANSACTIONS

Volume V
1914-16

Edited by

CARLETON REA and J. RAMSBOTTOM

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The British Mycological Society

KRAUS REPRINT LTD.
VADUZ
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COMMONWEALTH MYCOLOGICAL INSTITUTE
27 APR 1964

British Mycological Society.

LIST OF MEMBERS.

Honorary Members.

1. Boudier, Monsieur Emile, 22, rue Grétry, Montmorency (Seine-et-Oise), France (1905).

Foundation and Ordinary Members.

1. Acland, Sir Charles Thomas Dyke (Bart.), Holnicote, Taunton, Somerset and Killerton, Exeter (1899).
2. Adams, Mr. Alfred, M.A., M.B., Lemain, Looe, Cornwall (1902).
3. Adams, Rev. D. C. O., Monks Risboro, Princes Risboro (1907).
4. Allen, Mr. W. B., Benthall, Broseley, Salop (1902).
5. Bailey, Mr. Maurice A., B.A., John Innes Horticultural Institute, Mostyn Road, Merton, Surrey (1911).
6. Barrington, Dr. F. J. F., University College Hospital, Medical School, University Street, London, W.C. (1901).
7. Baumgarten, Miss Verena, 10, Eldon Square, Newcastle-upon-Tyne (1914).
8. Bayliss, Miss Jessie Sproat, D.Sc. B'ham., B.Sc. London, Lecturer and Demonstrator in Botany Birmingham University. (See Mrs. J. S. Bayliss Elliott.) (1911).
9. Biffen, Professor R. H., M.A., F.R.S., 136, Huntingdon Road, Cambridge (1899).
10. Bird, Mr. C. P., I.C.S. retired, J.P., F.R.H.S., Drybridge, Hereford (1901).
11. Blackman, Professor V. H., F.R.S., M.A., Professor of Plant Physiology and Pathology, Imperial College of Science, South Kensington, S.W. (1900).
12. Blagden, Mr. Charles Otto, The Sports Club, St. James Square, London, S.W. (1910).

13. Borthwick, Mr. A. W., D.Sc., Royal Botanic Garden, Edinburgh, and 46, George Street, Edinburgh (1911).
14. Boston, The Mycological Club, Boston, Mass., U.S.A. (1900).
15. Boyd, Mr. D. A., St. Clair, Caledonia Road, Saltcoats (1906).
16. British Museum, The Trustees of, Cromwell Road, London, S.W. (1914).
17. Brooks, Mr. F. T., M.A. (Senior Demonstrator of Botany, Cambridge University), The Botany School, Cambridge (1907).
18. Bruxelles, Jardin Botanique de l'État (1911).
19. Buller, Professor A. H. Reginald, D.Sc., Ph.D., F.R.S.C., Professor of Botany at the University of Manitoba, Winnipeg, Canada (1911).
20. Caley, Miss Dorothy M., John Innes Horticultural Institute, Mostyn Road, Merton (1913).
21. Carr, Professor J. W., M.A., University College, Nottingham (1896).
22. Cheesman, Mr. W. Norwood, J.P., F.L.S., The Crescent, Selby (1896).
23. Chicago, The Library, University of, Ill., U.S.A. (1914).
24. Claridge, Miss M., 8, Park Terrace, Oxford (1903).
25. Clarke, Rev. F. K., M.A., Orcheston, Malvern Wells (1896).
26. Compton, Mr. R. H., M.A., Caius College, Cambridge. (1912).
27. Cooper, Miss Charlotte A., The Vicarage, Robin Hood's Bay (1911).
28. Cortwright, Mr. K. F. H. G., The Knoll, Colwall (1913).
29. Cotton, Mr. Arthur D., F.L.S., The Herbarium, Royal Gardens, Kew (1902).
30. Crawford, Mr. W. C., M.A., F.R.S.E., 1, Lockharton Gardens, Edinburgh (1899).
31. Crossland, Mr. Charles, 4, Coleridge Street, Halifax (1896).
32. Darbishire, Dr. O. V., B.A., Ph.D., University College, Bristol (1913).
33. Davy, Lady Johanna C., Wintergreen Wood Pyrford, Woking (1913).
34. Delf, Miss E. M., Westfield College, University of London, Hampstead, N.W., and 96 Underhill Road, Dulwich (1914).
35. Drinkwater, Mr. Henry, M.D., C.M.Edin., M.R.C.S. Eng., F.R.S.E., Lister Lodge, Wrexham (1910).
36. Edwards, Mr. W. H., Curator, The Museum, Birmingham (1896).
37. Elliott, Mr. W. T., L.D.S., R.C.S., F.Z.S., Arden Grange, Tanworth-in-Arden, Warwickshire (1913).

37.* Elliott, Mrs. J. S. Bayliss, Arden Grange, Tanworth-in-Arden, Warwickshire (1911).
38. Ellis, Dr. John W., M.B., F.E.S., 18, Rodney Street, Liverpool (1910).
39. Evans, Mr. William, F.R.S.E., 38, Morningside Park, Edinburgh (1911).
40. Finlayson, Mr. Raymond, The Seed Testing Laboratory, Wood Green, London, N. (1910).
41. FitzGerald, Rev. H. P., F.L.S., Lidwells, Goudhurst, Kent (1896).
42. Fraser, Miss H. C. I., D.Sc., F.L.S., Birkbeck Institute, Chancery Lane, London. (See Mrs. H. C. I. Gwynne-Vaughan.) (1906).
43. Gardner, Mr. Frederic, 16, Stow Park Avenue, Newport (1898).
44. Gelsthorp, Mr. Thomas, Eastgate, Louth (1896).
45. Gibbs, Mr. Thomas, The Causeway, Wirksworth (1896).
46. Goodwin, Mr. D. P., Oakden, Kidderminster (1902).
47. Grant, Mr. Angus, Drumälan, Drumnadrochit, N.B. (1903).
48. Green, Lt.-Col. C. Theodore, R.A.M.C., M.R.C.S. England, L.R.C.P. London, F.L.S., 31, Shrewsbury Road, Birkenhead (1901).
49. Grinling, Mr. C. H., M.A., 17, Rectory Place, Woolwich (1913).
50. Groom, Professor Percy, M.A., D.Sc., Imperial College of Science and Technology, London (1914).
51. Gupta, Professor B. L., Professor of Biology, Reid Christian College, Lucknow, India (1914).
51.* Gwynne-Vaughan, Mrs. H. C. I., D.Sc., F.L.S., 14, London Road, Reading (1906).
52. Hadden, Mr. Norman G., St. Audreys, Priory Road, Malvern (1911).
53. Harrison, Mr. H. W., Harboro' Torrington Road, Liscard, Wallasey (1913).
54. Harrison, Mrs. E. Harboro', Torrington Road, Liscard, Wallasey (1913).
55. Hart, Mr. John William, F.R.H.S., Associate of University College, Reading, Bedford College for Women (University of London) Regent's Park, London, N.W. (1914).
56. Harvey, Mrs. Cecily D., Barwick in Elmet Rectory, near Leeds (1910).
57. Hastings, Mr. Somerville, M.A., F.R.C.S., 43, Devonshire Street, Portland Place, London, W. (1913).
58. Hawley, Sir H. C. (Bart.), Holly Mount, Hurst Wood, Buxted, Surrey (1907).

59. Hey, Mr. T., 8, Bloomfield Street, Derby (1896).
60. Hibbert-Ware, Miss Alice, 23, Fladgate Road, Leyton stone, Essex (1911).
61. Hildyard, Mr. F. W., 77A, Lexham Gardens, Kensington, London, W. (1913).
62. Hiley, Mr. Wilfrid E., M.A., Danesfield, Boar's Hill, Oxford (1913).
63. Holmes, Mr. E. Morell, F.L.S., F.R.H.S., Ruthven, Sevenoaks, Kent (1906).
64. Hughes, Mr. G. C., Chesterton, Bicester, Oxon. (1898).
65. Huish, Mr. Charles Henry, F.R.M.S., Danehurst, 24, Champion Grove, Denmark Hill, London, S.E. (1913).
66. Jack, Mr. H. W., B.Sc., B.A., Assistant Agricultural Inspector Federated Malay States, Waterloo Place, Cork (1913).
67. Jermyn, Col. T., Highcliff, Weston-Super-Mare (1912).
68. Johnstone, Mr. R. B., 70, Cambridge Drive, Glasgow (1908).
69. Kirtikar, Lieut.-Colonel Kanhoba, Ranchhoddas, F.L.S. (Member Association International des Botanists (Holland), M.R.C.S. Engl., L.R.C.P. London, Alexandra Lodge, Post Andheri (Thana District), near Bombay, India, Hon. Secretary Bot. Section Bombay Natural History Society (1909).
70. Knight, Mr. H. H., The Lodge, All Saints Villas, Cheltenham (1914).
71. Lang, Professor W. H., M.B., D.Sc., 2, Heaton Road, Withington, Manchester (1910).
72. Lister, Miss Gulielma, F.L.S., Leytonstone and Highcliff, Lyme Regis (1903).
73. Lloyd, Mr. C. G., The Lloyd Library and Museum, 224, West Court Street, Cincinnati, Ohio, U.S.A. (1907).
74. Macfie, Dr. John William Scott, B.A., Rowton Hall, Chester (1900).
75. Mackenzie, Mr. D., Afton, Busby, N.B. (1900).
76. Maire, Dr. René, D.Sc., Professeur à la Faculté des Sciences de l'Universite, Algers (Algeria) (1907).
77. Marmont, Mr. Basil P., Windsoredge House, Inchbrook, near Woodchester, Gloucestershire (1908).
78. Mason, Mr. F. A., F.R.M.S., Member of the Society of Public Analysts, The Laboratory, 3, Queen's Square, Leeds (1912).
79. Mercer, Mr. W. B., B.Sc., N.D.A., Armstrong College, Newcastle-upon-Tyne, and Abbots Bromley, Rugeley, Staffordshire (1913).
80. Missouri, The Botanical Garden, St. Louis, Ms. U.S.A. (1902).

81. Montague, Mrs. A., Penton, Crediton, N. Devon (1898).
82. Newcastle-upon-Tyne. The Literary and Philosophical Society (1902).
83. Newman, Mr. Leslie F., Dip. Agri. Cantab., Moor Hall, Shorley, Bishops Stortford, Herts., and School of Agriculture, Cambridge (1906).
84. New York Botanical Garden, Bronx Park, New York, U.S.A. (1904).
85. Nicholson, Mr. W. E., Lewes (1913).
86. Noel, Miss E. Emelia, 37, Moscow Court, London, W. (1913).
87. Ogilvie, Mr. George H., B.Sc., Indian Forest Service, Burmah, Westlands, Broughty Ferry, N.B. (1912).
88. Ogle Mr. B. S., Hill House, Steeple Aston, Oxon. (1904).
89. Oke, Mr. Alfred William, B.A., L.L.M., F.G.S., F.L.S., 32, Denmark Road, Hove (1908).
90. O'Loughlin, Miss Bessie, Rocklands, Wallasey, Cheshire (1913).
91. Osborn, Professor Theodore George Bentley, M.Sc., Professor of Botany, Adelaide University (1910).
92. Paul, Rev. David, LL.D., 53, Fountainhall Street, Edinburgh (1899).
93. Peacock, Dr. H. G., Hareston Lodge, Torquay (1896).
94. Pearson, Mr. Arthur A., 3, North View, Wimbledon Common (1911).
95. Peltereau, Monsieur E., Notaire honoraire, Trésorier de la Societé Mycologique de France, Vendome, (Loir et Cher.) France (1909).
96. Perceval, Mr. Cecil H. Spencer, Longwitton Hall, Morpeth (1901).
97. Petch, Mr. T., B.A., B.Sc., Royal Botanic Gardens, Peradeniya, Ceylon (1911).
98. Phillips, Professor Reginald W., M.A., D.Sc., F.L.S., Professor of Botany in University College, Bangor (1911).
99. Plowright, Mr. Charles Tertius Maclean, B.A., M.B., King Street, King's Lynn (1901).
100. Potter, Professor M. C., Sc.D., M.A., F.L.S., Armstrong College, Newcastle-upon-Tyne (1896).
101. Potts, Mr. George, Benthall House, Broseley, Salop (1910).
102. Price, Mr. S. Reginald, B.A., Fernleigh, Wellington, Somerset (1911).
103. Priestley, Professor J. H., B.Sc., F.L.S., Botanical Department, University of Leeds (1912).
104. Ramsbottom, Mr. J., M.A., British Museum, Cromwell Road, London, S.W. (1910).

105. Ramsbottom, Mr. J. K., Gardeners' Magazine, 2, Adelaide Road, Brentford, Middlesex (1914).
106. Rea, Mr. Carleton, B.C.L., M.A., &c., 34, Foregate Street, Worcester (1896).
107. Rea, Mrs. Emma Amy, 34, Forgate Street, Worcester (1896).
108. Robson, Mr. R., M.Sc., F.Z.S., Writtle, Chelmsford, Essex (1914).
109. Rushton, Mr. W., A.R.C.S., D.I.C., Demonstrator in Biology at St. Mary's Hospital Medical School, Paddington, W., and Assistant Lecturer in Botany at the South Western Polytechnical Institute, Chelsea, 4 Rosenan Road, Battersea, London, S.W. (1914).
110. Saunders, Miss E. R., F.L.S., Newnham College, Cambridge (1913).
111. Selborne, The, Society, 42, Bloomsbury Square, London, W.C. (1913).
112. Sewell, Rev. T. J., M.A., Lynsted, Sittingbourne, Kent (1912).
113. Shadwell, Miss Blanche, 21, Nottingham Place, London (1906).
114. Sharpe, Mr. C. J., Brambleside, Manor Road, Sidcup (1905).
115. Simon, Monsieur Eugene, 16, Villa Saïd, Paris (1906).
116. Smith, Miss Annie Lorrain, F.L.S., 20, Talgarth Road, West Kensington, S.W. (1899).
117. Smith, Mr. Worthington G., 121, High Street, Dunstable (1900).
118. Spinks, Mr. George T., B.A., Dep. Agri. Cantab., Trinity Hall College, Cambridge (1913).
119. Stoward, Dr. F., 69, Tate Street, Leederville, Western Australia (1914).
120. Sutherland, Mr. G. K., M.A., B.Sc., University College, Southampton (1914).
121. Swanton, Mr. E. W., Brockton, Haslemere (1899).
122. Tabor, Mr. Richard John, B.Sc., F.L.S., Imperial College of Science and Technology, South Kensington (1914).
123. Tatum, Mr. E. J., Salisbury (1896).
124. Taylor, Miss Beatrice Katherine, 98, Cheyne Walk, Chelsea, S.W. (1910).
125. Taylor, Mr. H. V., A.R.C.S., B.Sc., (Inspector, Board of Agriculture) 4, Whitehall Place, London (1913).
126. Thomas, Mr. H. Hamshaw, The Botany School, Cambridge (1910).
127. Tothill, Lieut. Vincent, R.A.M.C., Ilketshall, St. Andrew, Bungay, Suffolk (1912).
128. United States, Department of Agriculture (1907).

129. Vines, Professor S. H., M.A., D.Sc., F.R.S., Sherardian Professor of Botany, Botanic Garden, Oxford (1915).
130. Wager, Mr. Harold, F.R.S., F.L.S., Hendre, Horsforth Lane, Far Headingley, Leeds (1896).
131. Wakefield, Miss E. M., F.L.S., The Herbarium, Royal Botanic Gardens, Kew (1911).
132. Watkin, Mr. J., Savings Bank, Welshpool (1909).
133. Watson, Mr. William Charles Richard, Rosedale, Southlands Road, Bickley, Kent (1914).
134. Whetzel, Professor H. H., Professor of plant pathology, Cornell University, Ithaca, New York (1914).
135. Wilson, Mr. Malcolm, D.Sc., A.R.C.S., F.L.S., Royal Botanic Gardens, Edinburgh (1912).
136. Woolhope, The, Naturalists' Field Club, Hereford (1896).

OFFICERS FOR THE SEASON 1914.

President: Professor A. H. Reginald Buller, D.Sc., Ph. D., F.R.S.C. University of Manitoba, Winnipeg, Canada.

Vice-President: Miss Gulielma Lister, F.L.S., Leytonstone, Essex and Highcliff, Lyme Regis.

Hon. Secretary and Treasurer: Carleton Rea, B.C.L., M.A., &c., 34, Foregate Street, Worcester.

RULES.

Society's name and objects.

1. The Society shall be called "The British Mycological Society," and its objects shall be the study of Mycology in all its branches, systematic, morphological and pathological, the publication of annual reports recording all recent discoveries in any branch of mycology, and more especially giving a brief synopsis of the work of European Mycologists and the recent additions to the British Fungus Flora.

Members of Society.

2. The Society shall consist of Foundation Members, Honorary Members and Ordinary Members, the number of Foundation Members shall be limited to 100 and that of Honorary Members to 20, but the number of Ordinary Members shall be unlimited.

Foundation Members.

3. Foundation Members shall consist of those Members and Clubs who joined the Society previous to the limit of 100 Members of the Society having been attained, but after this number has been attained no Person or Club shall be admitted as a Foundation Member.*

Honorary Members.

4. Honorary Members shall be Ladies or Gentlemen of pre-eminence in Mycology, or who have rendered special service to the Society.

Ordinary Members.

5. Ordinary Members shall be Ladies or Gentlemen elected as hereinafter set out.

Election of Members.

6. Until the limit of 100 Foundation Members be reached* any person or Club may signify their desire of joining the British Mycological Society and will consequently be enrolled as Members thereof by the Secretary. Honorary Members shall only be elected at a meeting of The British Mycological Society by the majority of the Members then present. Ordi-

* The limit of 100 Foundation Members was reached 22nd October, 1903.

nary Members shall be elected either by the majority of the Members then present at the annual meeting, or meetings, or by the President, Vice-President, Treasurer, and Hon. Secretary at other times. All Ordinary Members shall be proposed and seconded respectively by existing Members, who shall sign a certificate (see appendix) in recommendation of him or her, one at least of the proposers so certifying from personal knowledge, and every candidate for election shall sign an undertaking to abide by the Rules if elected (see appendix).

Yearly Subscription.

7. All Ordinary Members and Clubs shall pay an annual subscription of 10/- and Foundation Members 5/-, and the same shall be due by the First of January in each year, whilst Honorary Members shall be exempt from any annual subscription. Any Member wishing to retire from the Society shall give notice to the Hon. Secretary in writing before 1st of December of the previous year, otherwise he shall be liable for the annual subscription for the next year.

Government of the Society.

8. The management of the British Mycological Society shall be vested in the President, Vice-President, Treasurer, and Hon. Secretary.

Election of Officers.

9. The President, Vice-President, Treasurer, and Hon. Secretary shall be elected annually, at the first meeting of the British Mycological Society in each year, by a majority of the Members then present.

Meetings or Forays.

10. The British Mycological Society shall hold one or more meetings annually at a place and time determined by the Members at the previous meeting, or in default thereof, by the President, Vice-President, Treasurer, and Secretary. Invitations from Local Societies shall be first entertained and the acceptance of such shall imply that the Local Society undertakes to arrange the excursions of the foray, obtain necessary permissions from landowners, and place at the disposal of the British Mycological Society a room, free of cost, for the exhibition of specimens, delivery of addresses, and the transaction of business.

Accounts to be annually furnished and vouched.

11. At the first meeting of the British Mycological Society in each year the Hon. Secretary shall produce an account of the receipts and disbursements for the previous year, duly vouched by the Hon. Treasurer, or if the two offices be combined, then by an independent Member of the Society.

Payment of Expenses.

12. At each Meeting the Members then present must pay to the Hon. Secretary their share of the expenses incurred.

Election of Chairman in absence of President and Vice-President.

13. In the absence of the President and Vice-President, the Members present at any meeting shall elect a Chairman for that Meeting.

Rarities to be recorded.

14. Members finding rare specimens, or specimens new to the British Fungus Flora, are requested to immediately communicate the fact to the Hon. Secretary, together with full descriptions, the locality, habitat, and the date thereof, and the Hon. Secretary shall report the same at the next meeting of the Society.

Every Member to have a copy of these Rules and any alteration thereof.

15. A printed copy of these Rules shall be sent to every Member of the Society on election, and to all Members on their alteration.

APPENDIX.

Form of proposal for Ordinary Membership of the British Mycological Society.

_____

*of*_____

_____

being desirous of becoming an Ordinary Member of the British Mycological Society, we, the undersigned Members of the Society, certify that we consider h to be a desirable Member of the Society, and beg to recommend h for election.

Dated this day of 19

_____(From personal knowledge).

_____

Certificate to be signed by the Candidate.

I hereby certify that I desire to become an Ordinary Member of the British Mycological Society and that I will abide by the Rules if elected.

_____

SYMONDS YAT SPRING FORAY.

29th May to the 2nd June, 1914.

The sixth informal spring foray of the British Mycological Society was held at Symonds Yat, Gloucestershire, from Friday the 29th of May, to Tuesday the 2nd of June, 1914. The members assembled during the afternoon and evening at The Royal Hotel, Symonds Yat, which constituted the headquarters of the Society for the meeting.

On Saturday, the 30th of May, at 9-30, the members started punctually from the headquarters under the guidance of a forester whom Mr. V. F. Leese (the Deputy Surveyor of the Forest of Dean) had most kindly directed to be in attendance. The walk first proceeded for some hundred yards down the entrancing gorge of the Wye Valley, and then a sharp and steep turn was taken into the woods and through well grown woodlands to Mailscot Lodge. The road was then crossed and a somewhat uninteresting residential portion crowded with many intersecting lanes and small houses was traversed. This is known as Berry Hill. The woodlands were again re-entered and the walk continued through Whynburry Bottoms to the Wood Distillation Works near the Speech House Road railway station. Here they were welcomed by Mr. T. Newcomen, who most kindly showed them over the works, and explained the way in which charcoal, tar, acetic acid and crude spirit (methylic alcohol) were extracted by the plant from the cord wood. Elm and Holly wood were unsuitable for the purpose and large stacks of cord wood had become unusable owing to the alteration of the cellulose caused by parasitical and saprophytical fungi. The stacks were then carefully searched and large quantities of *Isaria umbrina* (Pers.) Sacc. (the conidial condition of *Hypoxylon coccineum* (Bull.) Fries) were found. Miss Violet Rea gathered a very gregarious form of *Arachnopeziza aurelia* (Pers.) Fuck. Specimens of *Odontia barba-Jovis* (Bull.) Bres., *Badhamia capsulifera* Berk., and *Perichaena corticalis* Rost. were also obtained at this spot. Miss E. M. Wakefield subsequently reported the discovery of *Grandia helvetica* (Pers.) Fr.* which had been kindly confirmed by the Abbé H. Bourdot. The walk was then continued via The Speech House back to the headquarters.

* For description of this species see p. 134.

On the following day the woods on the Great Doward on the left bank of the Wye, in Herefordshire, were explored. The members spread out in all directions, some visiting the famous Prince Arthur's Cave, whilst others traversed the woods in an opposite direction. Specimens were again collected of *Odontia barba-Jovis* (Bull.) Bres., and Miss Wakefield added *Peniophora Molleriana* Bres.* to the British Fungus Flora. She also boxed *Peniophora glebulosa* (Fr.) Bres.† and *Corticium confine* Bourd. & Galz. Mr. W. E. Nicholson, returning on the left bank of the Wye near the Slaughter Rocks in Gloucestershire, obtained a fine gathering of the lovely little mycetozoon *Diderma Trevelyani* Fr., so like a Geaster in miniature.

In the evening, at the business meeting of the Club, after some considerable discussion it was decided to hold the Whitsuntide week-end spring foray for 1915 at Baslow, Derbyshire. Mr. G. K. Sutherland, M.A., B.Sc., of University College, Southampton, and Mr. H. H. Whetzel, Professor of Plant Pathology, of Cornell University, Ithaca, New York, were unanimously elected members of the Society. The Chairman welcomed Professor Whetzel's visit to the foray and expressed, on behalf of the members, the pleasure they had in having his company and assistance.

On Monday, the 1st of June, the members started from the headquarters at 10 o'clock, under the leadership of Mr. H. H. Knight. They proceeded down the Wye past the Slaughter and then turned up through the forest in the direction of the Double View. Professor Whetzel gathered some plants of Vaccinium that were badly infected with *Exobasidium Vaccinii* Woron., and Miss Wakefield collected a Poria that she subsequently determined to be *Poria eupora* Karst. In close proximity *Trichopeziza caesia* (Pers.) Boud. was found developing its ascophores on a fallen log. The walk was then continued through the village of Staunton-on-Wye to the Buckstone, and the adjoining woods were then investigated, but only some specimens of *Corticium porosum* Berk. & Curt. were of any interest. Next the Kymin hill was visited and the descent made into Monmouth, from whence the members returned to Symonds Yat by the six o'clock train.

In the evening a hearty vote of thanks was tendered to Mr. V. F. Leese (the Deputy Surveyor of the Forest of Dean) for his hearty welcome to the Forest and for so kindly sending a guide to conduct the members on the opening day, and to Mr. T. Newcomen for permission to visit his works and wood stacks. Mr. H. H. Knight, of the Lodge, All Saints Villas, Chelten-

* For description of this species see p. 132.
† For description of this species see p. 133.

ham, and Mr. W. H. Holt, of 17, Ashville Road, Birkenhead, were unanimously elected members of the Society.

On Tuesday, the 2nd of June, at ten o'clock, the members proceeded to the summit of the Yat and along the wooded walk above the Coldwell Rocks. Mr. Norman G. Hadden found a few sporangia of *Didymium Clavus* Rost. and *Comatricha pulchella* Rost. var. *tenerrima* Lister. The return was made via the base of the Coldwell Rocks and the woods jutting out into the horse-shoe that the Wye here makes, and which are in Herefordshire, were worked. Miss Wakefield was again fortunate and secured some specimens of *Ramularia Anthrisci* v. Höhn on leaves of *Anthriscus sylvestris*, which is new to Britain. Dr. J. W. Ellis also records from the Yat *Staganospora Luzulae** (West.) Sacc., which is another addition to the British list. Plants of *Vinca major* growing in the garden at The Royal Hotel were covered with *Puccinia Vincae* Berk. in all its stages, including the aecidiospores described by Dr. Plowright. About two hundred species of fungi were collected during the foray, and Mr. Norman G. Hadden handed in a list of mycetozoa including twenty-six species and one variety.

* For description of this species see p. 135.

COMPLETE LIST OF FUNGI GATHERED DURING THE FORAY.

B. = Symonds Yat to the Buckstone, Gloucestershire; *D.* = Great Doward Hill, Herefordshire; *S.* = Symonds Yat to the Speech House, Gloucestershire; *Y.* = Symonds Yat and Coldwell Rocks, Gloucestershire.

Amanita rubescens Fr. *S.*

Collybia platyphylla (Pers.) Fr. *S.*, succinea Fr. *B.*, aquosa (Bull.) Fr. *B.*, ocellata Fr. *B.*

Mycena rugosa Fr. *B.*, polygramma (Bull.) Fr. *D.*, filopes (Bull.) Fr. *D.*, acicula (Schaeff.) Fr. *D.*, *S.*, galopus (Pers.) Fr. *B.*

Panus stypticus *S.*

Lenzites betulina (Linn.) Fr. *S.*, *Y.*

Entoloma sericeum (Bull.) Fr. *B.*

Pholiota praecox (Pers.) Fr. *B.*, *S.*, *Y.*

Inocybe rimosa (Bull.) Fr. *S.*

Galera hypnorum (Schrank) Fr. *B.*, *D.*, *S.*

Tubaria furfuracea (Pers.) W. G. Sm. *D.*, *S.*

Stropharia semiglobata (Batsch) Fr. *B.*

Hypholoma fasciculare (Huds.) Fr. *S.*, *Y.*, hydrophilum (Bull.) Fr. *D.*

Psathyra fibrillosa (Pers.) Fr. *S.*

Coprinus micaceus (Bull.) Fr. *D.*, plicatilis (Curt.) Fr. *S.*, *Y.*

Psathyrella atomata Fr. *B.*

Polyporus squamosus (Huds.) Fr. *Y.*, varius (Pers.) Fr. *D.*, rutilans (Pers.) Fr. *B.*, adustus (Willd.) Fr. *D.*, *S.*, *Y.*

Fomes australis (Fr.) Pat. *D.*, annosus Fr. *B.*, *S.*

Polystictus versicolor (Linn.) Fr. *B.*, *S.*, velutinus (Pers.) Fr. *S.*, *Y.*

Poria mollusca (Pers.) Fr. *B.*, eupora Karst. *B.*

Trametes gibbosa (Pers.) Fr. *Y.*

Daedalea quercina (Linn.) Fr. *S.*, *Y.*

Merulius corium (Pers.) Fr. *S.*, *Y.*

Solenia anomala (Pers.) Fr. *B.*, fasciculata (Pers.) Fr. *D.*

Irpex obliquus (Schrad.) Fr. *B.*, *D.*, *Y.*

Grandinia helvetica* (Pers.) Fr. (fide H. Bourdot) *S.*

Odontia barba-Jovis (Bull.) sensu Bresadola *B.*, *D.*, *S.*

Stereum hirsutum (Willd.) Fr. *B.*, *D.*, *S.*, *Y.*, purpureum (Pers.) Fr. *B.*, spadiceum (Pers.) Fr. *B.*, *S.*

Hymenochaete corrugata (Fr.) Lév. *B.*, *D.*

* For description of this species see p. 134.

Corticium porosum Berk. & Curt. *B.*, *D.*, confine Bourd. & Galz. *D.*, Sambuci (Pers.) Fr. *D.*

Peniophora glebulosa (Fr.) Bres.* *B.*, *D.*, velutina (DC.) Cke. *Y.*, Molleriana† Bres. (new to Britain) *D.*, cinerea (Pers.) Cke. *D.*, setigera (Fr.) Bres. (=Kneiffia) *S.*, *Y.*

Auricularia (=Hirneola) Auricula-Judae (Linn.) Schröt. *D.*, *S.*, mesenterica (Dicks.) Fr. *D.*, *S.*, *Y.*

Exidia glandulosa (Bull.) Fr. *B.*, albida (Huds.) Bref. *D.*

Tremella indecorata Sommf. *Y.*

Dacryomyces deliquescens (Bull.) Duby *D.*, *S.*, stillatus (Nees) Fr. *S.*, *Y.*

Exobasidium Vaccinii Woron. *B.*, *S.*

Bovista plumbea Pers. *D.*, *S.*

Uromyces Ficariae (Schum.) Lév. *B.*, *Y.*, Valerianae (Schum.) Fuck. *B.*, *Y.*, Scillarum (Grev.) Wint. *D.*, Poae Rabenh. *Y.*

Puccinia Violae (Schum.) DC., *B.*, *Y.*, Lychnidearum Link. *D.*, Epilobii DC. *D.*, Aegopodii (Schum.) Mart. *B.*, *Y.*, Angelicae (Schum.) Fuck. *B.*, obtegens (Link) Tul. *D.*, *S.*, *Y.*, Hieracii *Y.*, Lampsanae (Schultz.) Fuck. *Y.*, Taraxaci Plowr. *B.*, *Y.*, Hypochaeridis Oud. *Y.*, Vincae (DC.) Berk. *Y.*, Betonicae (A. & S.) DC. *B.*, Menthae Pers.*D.*, Iridis (DC.) Wallr. Y., Caricis (Schum.) Rebent. *on Carex pendula, Y.*, Scirpi DC. *B.*, Lolii Niels. *on Rhamnus catharticus Y.*, glumarum (Sch.) Erikss. & Henn. *B.*, *D.*, Phalaridis Plow. *on Arum maculatum, D.*, Poarum Niels. *on Tussilago, B.*

Triphragmium Ulmariae (Schum.) Link *Y.*

Phragmidium Fragariae (DC.) Wint. *B.*, *S.*, cylindricum Bon. *D.*, mucronatum (Pers.) Schlecht. *D.*, *Y.*, violaceum (Schultz) Wint. *B.*, *Y.*

Endophyllum Euphorbiae-silvaticae (DC.) Wint. *on Euphorbia amygdaloides, B., D.*

Coleosporium Melampyri (Rebent.) Kleb. *B.*, Tussilaginis (Pers.) Kleb. *Y.*

Ochropsora Ariae (Fuck.) Ramsb. *on Anemone nemorosa, Y.*

Uredinopsis Scolopendrii (Fuck.) Rostr. *B.*

Melampsora Rostrupii Wagn. *on Mercurialis perennis, B.*

Ustilago Avenae (Pers.) Jens. *on Arrhenatherum elatius, Y.* Tragopogi (Pers.) Schröt. *Y.*

Urocystis Anemones (Pers.) Wint. *B.*

Synchytrium Taraxaci de Bary & Woron. *B.*, *D.*, *S.*

Pycnochytrium aureum Schröt. *on Plantago lanceolata, B., D.*

Cystopus candidus (Pers.) Lév. *Y.*, Tragopogonis (Pers.) Schröt. *Y.*

Peronospora calotheca de Bary, *on Asperula odorata, B.*, Ficariae Tul. *Y.*

* For description of these species see page 133.
† For description of this species see p. 132.

Spinellus fusiger (Link) van Tiegh. *S.*
Pilobolus crystallinus (Wigg.) Tde. *Y.*
Pilaira anomala (Ces.) Schröt. *S.*
Protomyces Ari Cke. *B., D.*
Aleuria vesiculosa (Bull.) Boud. *B.*
Pustularia cupularis (Linn.) Fuck. *D.*
Ciliaria scutellata (Linn.) Quél. *B.*
Coprobia granulata (Bull.) Boud. *S.*
Exoascus deformans (Berk.) Fuck. *Y.*
Coryne sarcoides (Jacq.) Tul. *S.*
Bulgaria inquinans (Pers.) Fr. *B., S., Y.*
Calloria fusarioides (Berk.) Fr. *S., Y.*
Orbilia xanthostigma Fr. *B., S.*
Chlorosplenium aeruginosum (Oeder.) de Not. *B., S.*
Helotium herbarum (Pers.) Fr. *D.*, virgultorum (Wahl.) Karst. *B.*
Dasyscypha virginea (Batsch) Fr. *B.*, nivea (Hedw. fil.) Sacc. *B., D.*
Trichoscypha calycina (Schum.) Boud. *B., S.*
Arachnopeziza aurelia (Pers.) Fuck. *S.*
Trichopeziza caesia (Pers.) Boud. *B.*
Mollisia cinerea (Batsch) Karst. *B., S., Y.*, melaleuca (Fr.) Sacc. *D., S.*
Heterosphaeria patella (Tode) Grev. *D., Y.*
Propolis faginea (Schrad.) Karst. *D.*
Pseudopeziza repanda (Fr.) Karst. *on Asperula odorata B.*
Stegia Ilicis Fr. *Y.*
Colpoma quercinum (Pers.) Wallr. *D., S.*
Hysterographium Fraxini (Pers.) de Not. *D.*
Hypoderma virgultorum DC. *D.*
Dichaena faginea (Pers.) Fr. *D.*
Gloniopsis curvata (Fr.) Sacc. *D.*
Spaerotheca castagnei Lév. *B., D.*
Erysiphe graminis DC. *Y.*
Nectria cinnabarina (Tode) Fr. *S., Y.*, episphaeria (Tode) Fr. *B., S.*
Chaetomium elatum Kunze *Y.*
Epichloe typhina (Pers.) Tul. *B., D.*
Trichosphaeria pilosa (Pers.) Fckl. *S.*
Leptospora spermoides (Hoffm.) Fuck. *D.*, ovina (Pers.) Fuck. *D.*
Stigmatea Robertiani Fr., *B., D., Y.*
Sphaerella hedericola (Desm.) Cke. *Y.*
Leptosphaeria acuta (Moug. & Nestl.) Karst. *D., S.*, culmicola Auersw. *D.*
Pleospora herbarum (Pers.) Rabh. *S.*
Ophiobolus acuminatus (Sow.) Duby *B., S.*
Massaria eburnea Tul. *D.*

Valsa lata (Pers.) Nke. *D.*, *Y.*, populina (Pers.) Wint. *D.*, *Y.*
Melanconis stilbostoma (Fr.) Tul. *D.*, *S.*
Diatrypella quercina (Pers.) Nke. *D.*, *S.*
Diatrype stigma (Hoffm.) de Not. *D.*, *S.*, disciforme (Hoffm.) Fr. *B.*, *D.*, *S.*
Hypoxylon serpens (Pers.) Fr. *D.*, fuscum (Pers.) Fr. *B.*, *S.*, coccineum (Bull.) Fr. *S.*
Ustulina vulgaris Tul. *D.*
Xylaria polymorpha (Pers.) Grev. *Y.*, hypoxylon (Linn.) Grev. *B.*, *D.*, *S.*, *Y.*
Phyllachora Junci (Fr.) Fckl. *S.*, graminis (Pers.) Fckl. *B.*, *D.*
Rhopographus Pteridis (Sow.) Wint. *B.*, *S.*
Phoma acuta Fuck. *D.*, hysterella Sacc. *Y.*, Urticae Schultz. & Sacc. *D.*
Darluca Filum (Bivon.) Cast. *Y.*
Actinonema Rosae (Lib.) Fr. *Y.*
Stagonospora Luzulae* (West.) Sacc. *Y.* (new to Britain).
Septoria Geranii Rob. & Desm. *on Geranium lucidum*, *Y.*, Hederae Desm. *D.*, *Y.*, Stachidis Rob. & Desm. *D.*
Oidium alphitoides Griff. & Maulb. *B.*, *S.*, Crataegi Grogn. *Kymin.*
Trichoderma lignorum (Tode) Harz *D.*, *S.*
Ovularia obliqua (Cke.) Oudem. *on Rumex*, *Y.*
Botrytis cinerea (Pers.) Fr. *D.*
Ramularia ovata Fuck. *Y.*, Anthrisci v. Höhn. *Y.* (first record), variabilis Fuck. *on leaves of Digitalis purpurea*, *B.*, Taraxaci Karst. *S.*
Torula herbarum Link *S.*
Periconia byssoides (Pers.) Cda. *D.*, pycnospora Fres. *Kymin.*
Bispora monilioides Cda. *B.*, *S.*
Fusicladium dendriticum (Wallr.) Fuck. *on leaves of Pyrus torminalis*, *B.*
Polythrincium Trifolii Kze. & Schm. *D.*
Cladosporium herbarum (Pers.) Chev. *Y.*
Helminthosporium velutinum (Link) Chev. *S.*
Cercospora mercurialis Passer. *D.*, *Y.*
Tilachlidium tomentosum (Schrad.) Lindau *S.*
Isaria umbrina (Pers.) Sacc. *B.*, *D.*, *S.*
Aegerita candida (Pers.) Grev. *S.*

Mycetozoa.†

Badhamia capsulifera Berk. *S.*, utricularis Berk. *S.*
Physarum viride Pers. *Mailscot and B.*, nutans Pers. *S.*

* For description of this addition see p. 135.

† Mr. Norman G. Hadden kindly furnished me with this list, which was subsequently verified by Miss Gulielma Lister, F.L.S.

Fuligo septica Gmel. *S.*, *Y.*
Craterium minutum Fr. *D.*, *Y.*
Diderma spumarioides Fr. *Y.* (abundant on dead Beech leaves), Trevelyani Fr., *near the Slaughter Rocks (Gloucestershire)*, difforme Duby. *B.*, *Y.*, Clavus Rost. *Y.*, melanospermum Macbride *Y.*, nigripes Fr. *Y.*, squamulosum Fr. *B.*, *D.*, *Y.* Abundant.
Stemonitis fusca Roth. *S.*, ferruginea Ehrenb. *Y.* A quantity of white plasmodium which matured well in-doors.
Comatricha nigra Schr. *B.*, *D.*, *S.*, pulchella Rost. var. tenerrima Lister *Y. and Tintern (Monmouthshire).*
Lamproderma scintillans Morgan *Y.*
Reticularia Lycoperdon Bull. *S.*
Lycogala epidendrum Fr. Abundant in Gloucestershire, Herefordshire and Monmouthshire.
Trichia affinis de Bary *B.*, persimilis Karst. *D.*, *Y.*, scabra Rost. *Y.*, decipiens Macbride *Y.*, Botrytis Pers. *Y.*
Arcyria incarnata Pers. *B.*, *Y.*
Perichaena corticalis Rost. *S.*

THE DONCASTER FORAY.

21st to the 26th September, 1914.

The eighteenth annual week's fungus foray of the British Mycological Society was held at Doncaster. On Monday, the 21st of September, 1914, the members assembled at the headquarters, The Danum Hotel, Doncaster, where a room was reserved for the exclusive use of the Society.

On Tuesday, the 22nd of September, a start was made from the headquarters at ten o'clock, under the leadership of Dr. H. H. Corbett, in the direction of Cusworth, distant about one and a half miles from Doncaster. A timber yard was first carefully inspected, and detained the members for some considerable time. Mr. C. J. Sharpe obtained some nice examples of *Pluteus villosus* (Bull.) Fr., whilst the other more noteworthy fungi included *Mycena acicula* (Schaeff.) Fr., *Collybia eriocephala* Rea, *Pleurotus subpalmatus* Fr. and *Pleurotus lignatilis* (Pers.) Fr. The walk was continued across some pastures, where several clumps of *Psathyrella subatrata* Fr. were gathered. Some narrow plantations of Beech trees were next traversed, leading by an ancient neolithic encampment to some woods adjoining Cusworth House. These were found to be very dry owing to the prolonged drought. Subsequently Dr. J. W. Ellis reported the occurrence of *Pseudopeziza Ranunculi* (Wallr.) Fckl., and Miss Wakefield *Corticium confluens* (Fr.) sensu Bres. *Corticium confine* Bourdot & Galzin, *Corticium praetermissum* (Karst.) Bres.* and *Peniophora cremea* Bres.† Mr. A. D. Cotton found *Clavaria persimilis* Cotton and Miss Gulielma Lister handed in *Corynella atrovirens* (Pers.) Boud. The return was then made across the fields to Doncaster. In the evening, at nine o'clock, the President (Professor A. H. Reginald Buller, D.Sc., Ph.D., F.R.S.C.) took the chair, and the following officers were unanimously elected for the ensuing year:—Mrs. Emma Amy Rea, President; Miss Gulielma Lister, F.L.S., Vice-President; and Mr. Carleton Rea, B.C.L., M.A., &c., Hon. Secretary and Treasurer. The Hon. Secretary reported that at the spring foray held at Symonds Yat Mr. Wakefield most kindly suggested that the autumn foray for 1915 should be held at Swansea, but he was doubtful whether that offer stood good in the event of the present European war not having arrived at a conclusion by that time. Miss

* For description of this species see p. 130.
† For description of this species see p. 131.

Gulielma Lister proposed Sidmouth as a centre, and after considerable discussion it was decided to select Swansea for the place of meeting next year, provided Mr. Wakefield could in July, 1915, make satisfactory arrangements for the foray, otherwise Sidmouth to be the headquarters for the autumn foray from the 27th of September to the 2nd of October, 1915. Miss A. Lorrain Smith, F.L.S., was appointed delegate to represent the British Mycological Society at the Conference of Delegates of Corresponding Societies of the British Association in 1915, and the subject suggested for discussion thereat "Colour Standards." The Hon. Treasurer reported that they now had £8. 19s. 11d. in hand, against the adverse balance of £13. 0s. 1d. disclosed in the annual statement of accounts made up to the 31st July, 1914, set out in their programme of the foray, and that he hoped shortly to clear this off. The legacy of fifty pounds bequeathed by the late Mrs. E. M. Robinson to the British Mycological Society had now been paid over less legacy duty and the residue, £45, placed on deposit account with the Capital and Counties Bank Limited, Worcester, in the name of the British Mycological Society, on the 9th July, 1914. The members now numbered one hundred and forty and included three new members elected since the spring foray, namely, The Trustees of the British Museum (Natural History), Cromwell Road, London, S.W.; Professor B. L. Gupta, Reid Christian College, Lucknow, India; and The Library, University of Chicago, Illinois, United States of America.

On Wednesday, the 23rd of September, the morning was devoted to the determination of the fungi gathered on the previous day, and at 12 o'clock the tram was taken to the Doncaster Racecourse. A traverse was taken across this to the Wheatley Woods, but not a single fungus was observed, owing to its very dry condition. Wheatley Woods consist of a mixture of Pines, Larches, Oaks, Birches and Hazel. The conditions here were somewhat moister and a fair number of the larger fungi were present, including *Amanita pantherina* (DC.) Fr., *Amanita spissa* Fr., *Russula nitida* (Pers.) Fr., *Clavaria luteoalba* Rea, *Corticium praetermissum* (Karst.) Bres., *Corticium confine* Bourdot & Galzin, *Corticium subcoronatum* v. H. & L., *Peniophora pallidula* Bres.,* *Poria hymenocystis* B. & Br., and *Onygena corvina* (A. & S.) Fr. Sandall Beat was next visited, and Miss C. A. Cooper found some specimens of *Hygrophorus turundus* Fr. The sides of a straight cut ditch were found covered for some feet with the sporophores of a Polypore which was subsequently determined to be *Polyporus adiposus* B. & Br.

* See p. 134.

In the evening, at nine o'clock, Professor A. H. Reginald Buller delivered his presidential address entitled "The Fungus Lore of the Greeks and Romans" (see p. 21).

On Thursday, the 24th of September, the members assembled at the railway station and booked to Medge Hall by the 12-9 p.m. train for the exploration of Thorne Moor. This extensive moor was entered at a part called New Zealand and a typical fen carr thoroughly worked. *Amanitopsis fulva* (Schaeff.) W. G. Sm. grew in great abundance and was much enjoyed at breakfast on the following day. The culms of the rushes were found much attacked by the sclerotium of *Sclerotinia Curreyana* (Berk.) Karst. On the return walk, near to the railway station, Dr. J. W. Ellis gathered *Puccinia Sonchi* Roberge, *Mycosphaerella Iridis* (Auers.) Schroet., and *Urceolella leuconica* (Cke.) Boud.

In the evening, at nine o'clock, Miss Gulielma Lister, F.L.S., read some "Notes on Mycetozoa from Japan" (see p. 67), and Professor Buller followed with a paper "On the discharge of sporidia in *Puccinia graminis*."

On Friday, the 25th September, as few critical specimens remained to detain them, the members started at eleven o'clock and drove down to Edlington Wood. This wood is situate on the magnesian limestone and consists of deciduous trees and conifers. The most noteworthy finds included *Poria eupora* Karst., *Corticium subcoronatum* v. H. & L., *Psaliota comtula* Fr., *Lepiota sistrata* Fr., *Hygrophorus ceraceus* (Wulf.) Fr. and *Collybia vertirugis* Cke. Just before leaving the wood to rejoin the brakes Mr. J. Ramsbottom secured the best find of the foray, namely, *Tricholoma psammopum* Kalchbr., which is an addition to the British Fungus Flora. Miss Wakefield subsequently reported *Hypochnella violacea* Auersw.* and *Peniophora subalutacea* (Karst.) v. H. & L.†; both of these are new to Britain.

In the evening the President took the chair at nine o'clock, and read a paper on "The pseudorhiza of *Coprinus macrorhizus*." A hearty vote of thanks was then passed to Dr. H. H. Corbett for all the trouble that he had taken in arranging the details of their programme, for his leadership in the field and that of his son, and he was further requested to convey to the various landowners and tenants thanks for their kind permission, so readily accorded, to visit their estates. Over three hundred and thirty species of fungi were collected during the foray, and this must be considered a satisfactory total, as a prolonged drought had prevailed in this district before the foray. The Hon. Secretary has to thank Mr. A. D. Cotton, Mr. J. Ramsbottom, Miss E. M. Wakefield, and Dr. J. W. Ellis, for their kind assistance in preparing the subjoined list.

* For description of this species see p. 127.
† For description of this species see p. 133.

COMPLETE LIST OF FUNGI GATHERED DURING THE FORAY.

C. = Cusworth; *E* = Edlington Wood; *S.* = Sandall Beat; *T.* = Thorne Moor; *W.* = Wheatley Wood.

Amanita phalloides (Vaill.) Fr. *E.*, *W.*, mappa Fr. *S.*, muscaria (Linn.) Fr. *T.*, pantherina (DC.) Fr. *W.*, rubescens (Pers.) Fr. *T.*, *W.*, spissa Fr. *W.*

Amanitopsis fulva (Schaeff.) W. G. Sm. *T.*, *W.*

Lepiota gracilenta (Krombh.) Fr. *C.*, *E.*, cristata (A. & S.) Fr. *C.*, *E.*, sistrata Fr. *E.*

Tricholoma rutilans (Schaeff.) Fr. *W.*, psammopum Kalchbr. (new to Britain) *E.*, cuneifolium Fr. *S.*, melaleucum (Pers.) Fr. *C.*

Clitocybe clavipes (Pers.) Fr. *W.*, inversa (Scop.) Berk. *C.*, *W.*, metachroa (Fr.) Berk. *W.*

Laccaria laccata (Scop.) B. & Br. *T.*, *W.*, tortilis (Bolt.) Boud. *W.*

Collybia radicata (Relh.) Berk. *W.*, eriocephala Rea *C.*, platyphylla (Pers.) Fr. *W.*, fusipes (Bull.) Berk. *C.*, maculata (A. & S.) Fr. *T.*, *W.*, butyracea (Bull.) Fr. *T.*, *W.*, velutipes (Curt.) Fr. *E.*, vertirugis Cke. *E.*, confluens (Pers.) Fr. *C.*, *W.*, tenacella (Pers.) Fr. *W.*, acervata Fr. *E.*, *T.*, dryophila (Bull.) Fr. *E.*, *W.*

Mycena luteoalba (Bolt.) Fr. *C.*, lactea (Pers.) Fr. *C.*, rugosa Fr. *T.*, galericulata (Scop.) Fr. *C.*, *T.*, *W.*, polygramma (Bull.) Fr. *C.*, alcalina Fr. *C.*, *E.*, filopes *W.*, amicta Fr. *T.*, acicula (Schaeff.) Fr. *C.*, sanguinolenta (A. & S.) Fr. *W.*, galopus (Pers.) Fr. *C.*, *E.*, var. leucogala Cke. *T.*, var. alba Fl. Dan. *T.*, tenerrima Berk. *C.*, corticola (Schum.) Fr. *C.*

Omphalia grisea Fr. *C.*, fibula (Bull.) Fr. *W.*, var. Swartzii Fr. *T.*, integrella (Pers.) Fr. *C.*

Pleurotus subpalmatus Fr. *C.*, lignatilis (Pers.) Fr. *C.*, ostreatus (Jacq.) Fr. *C.*

Hygrophorus pratensis (Pers.) Fr. *C.*, virgineus (Wulf.) Fr. *C.*, ceraceus (Wulf.) Fr. *E.*, coccineus (Schaeff.) Fr. *C.*, turundus Fr. *S.*, puniceus Fr. *C.*, conicus Fr. *C.*, chlorophanus Fr. *C.*, psittacinus (Schaeff.) Fr. *C.*

Lactarius turpis (Weinm.) Fr. *T.*, *W.*, pyrogalus (Bull.) Fr. *S.*, pallidus (Pers.) Fr. *W.*, quietus Fr., *E.*, *T.*, *W.*, vietus Fr. *T.*, rufus (Scop.) Fr. *T.*, *W.*, glyciosmus Fr. *W.*, serifluus (DC.) Fr. *W.*, subdulcis (Pers.) Fr. *T.*, *W.*

Russula nigricans (Bull.) Fr. *E.*, *W.*, adusta (Pers.) Fr. *W.*, chloroides (Krombh.) Bres. *E.*, furcata (Pers.) Fr. *C.*, *W.*, drimeia Cke. *T.*, rubra Fr. *W.*, cyanoxantha (Schaeff.) Fr. *E.*, *T.*, *W.*, galochroa Fr. *S.*, foetens (Pers.) Fr. *C.*, *S.*, ochroleuca (Pers.) Fr. *T.*, *W.*, fragilis (Pers.) Fr. *T.*, *W.*, var. nivea (Pers.) Cke. *T.*, var. violacea Quél. *T.*, nitida (Pers.) Fr. *W.*, lutea (Huds.) Fr. *W.*

Cantharellus cibarius Fr. *W.*

Marasmius peronatus (Bolt.) Fr. *C.*, *W.*, ramealis (Bull.) Fr. *E.*, *T.*, rotula (Scop.) Fr. *C.*, *E.*

Panus stypticus (Bull.) Fr. *C.*

Lenzites betulina (Linn.) Fr. *C.*, saepiaria (Wulf.) Fr. *T.*

Pluteus cervinus (Schaeff.) Fr. *T.*, *W.*, villosus (Bull.) Fr. *C.*

Entoloma lividum (Bull.) Fr. *T.*, jubatum Fr. *C.*, sericeum (Bull.) Fr. *W.*, nidorosum Fr. *T.*

Leptonia lampropus Fr. *C.*, chloropolia Fr. *C.*, sericella (Fr.) Quél. *E.*

Nolanea pascua (Pers.) Fr. *W.*

Pholiota ombrophila Fr. *T.*, squarrosa (Müll.) Fr. *Askern*, mutabilis (Schaeff.) Fr. *E.*, *W.*

Inocybe pyriodora (Pers.) Fr. *C.*, rimosa (Bull.) Fr. *C.*, *E.*, asterospora Quél. *T.*, geophylla (Sow.) Fr. *E.*, *W.*

Hebeloma fastibile Fr. *T.*, *W.*, mesophaeum Fr. *E.*, crustuliniforme (Bull.) Fr. *E.*, *T.*

Flammula inopus Fr. *E.*, sapinea Fr. *W.*

Naucoria semiorbicularis (Bull.) Fr. *C.*, sobria Fr. *E.*, escharoides Fr. *T.*

Galera tenera (Schaeff.) Fr. *C.*, *W.*, hypnorum (Schrank) Fr. *E.*, *T.*

Tubaria furfuracea (Pers.) W. G. Sm. *C.*, *T.*, crobulus Fr. *E.*

Cortinarius (Dermocybe) caninus Fr. *E.*, *W.*

(Telamonia) torvus Fr. *T.*, hinnuleus (Sow.) Fr. *Askern*, rigidus (Scop.) Fr. *W.*

(Hydrocybe) castaneus (Bull.) Fr. *W.*

Paxillus involutus (Batsch) Fr. *E.*, *T.*, *W.*

Psaliota campestris (Linn.) Fr. *C.*, haemorrhoidaria Kalchbr. *E.*, comtula Fr. *E.*

Stropharia aeruginosa (Curt.) Fr. *C.*, semiglobata (Batsch) Fr. *C.*, *W.*

Hypholoma epixanthum (Paul.) Fr. *C.*, *E.*, *W.*, fasciculare (Huds.) Fr. *C.*, *T.*, *W.*, velutinum (Pers.) Fr. *S.*, appendiculatum (Bull.) Fr. *C.*, *E.*, *T.*, hydrophilum (Bull.) Fr. *W.*

Psilocybe semilanceata Fr. *T.*, *W.*, foenisecii (Pers.) Fr. *C.*
Psathyra corrugis (Pers.) Fr. *C.*, bifrons Berk. *C.*, fibrillosa (Pers.) Fr. *W.*
Bolbitius titubans (Bull.) Fr. *C.*
Coprinus atramentarius (Bull.) Fr. *C.*, cinereus (Schaeff.) Fr. *C.*, *E.*, niveus (Pers.) Fr. *C.*, micaceus (Bull.) Fr. *C.*, *W.*, radians (Desm.) Fr. *C.*, Friesii Quél. *C.*, ephemerus (Bull.) Fr. *C.*, plicatilis (Curt.) Fr. *C.*
Panaeolus campanulatus (Linn.) Fr. *C.*, *T.*, papilionaceus (Bull.) Fr. *C.*
Psathyrella subatrata Fr. *C.*, gracilis (Pers.) Fr. *C.*, *W.*, atomata Fr. *C.*, disseminata (Pers.) Fr. *C.*
Boletus elegans (Schum.) Fr. *T.*, badius Fr. *T.*, chrysenteron (Bull.) Fr. *W.*, subtomentosus (Linn.) Fr. *C.*, *W.*, scaber (Bull.) Fr. *S.*, *T.*
Fistulina hepatica (Huds.) Fr. *C.*, *T.*
Polyporus squamosus (Huds.) Fr. *C.*, *E.*, lacteus Fr. *W.*, caesius (Schrad.) Fr. *W.*, adustus (Willd.) Fr. *C.*, *T.*, adiposus B. & Br. *S.*, hispidus (Bull.) Fr. *C.*, *E.*, betulinus (Bull.) Fr. *T.*, *W.*
Fomes applanatus (Pers.) Wallr. *C.*, igniarius (Linn.) Fr. *C.*, connatus Fr. *C.*, annosus Fr. *W.*
Polystictus perennis (Linn.) Fr. *W.*, versicolor (Linn.) Fr. *C.*, *E.*, *W.*
Poria mollusca (Pers.) Fr. *W.*, medulla-panis (Pers.) Fr. *C.*, eupora Karst. *E.*, sanguinolenta (A. & S.) Fr. *C.*, *E.*, hymenocystis B. & Br. *W.*, viridans B. & Br. *E.*, ferruginosa (Schrad.) Fr. *C.*, blepharistoma B. & Br. *W.*
Daedalea quercina (Linn.) Fr. *E.*
Hydnum alutaceum Fr. *C.*, squalinum Fr. *E.*, udum Fr. *C.*, *E.*, farinaceum (Pers.) Fr. *C.*, *E.*, *W.*
Irpex obliquus (Schrad.) Fr. *C.*, *E.*, *W.*
Phlebia merismoides Fr. *C.*, vaga Fr. *C.*, *W.*
Grandinia granulosa Fr. *C.*
Odontia fimbriata (Pers.) Fr. *E.*
Stereum hirsutum (Willd.) Fr. *C.*, *E.*, *T.*, *W.*, spadiceum (Pers.) Fr. *C.*, *E.*, sanguinolentum (A. & S.) Fr. *C.*, rugosum (Pers.) Fr. *C.*, *E.*
Corticium laeve (Pers.) Fr. *C.*, confluens Fr. (sensu Bres.) *C.*, Sambuci (Pers.) Fr. *C.*, *E.*, *W.*, confine Bourdot & Galzin *C.*, *W.*, subcoronatum v. H. & L. *E.* *W.*, praetermissum* (Karst.) Bres. *C.*, *W.*
Hypochnella violacea† Auersw. *E.* (new to Britain).
Peniophora cinerea (Pers.) Cke. *E.*, *T.*, *W.*, velutina (DC.) Cke. *C.*, *W.*, pubera (Fr.) Sacc. *E.*, *W.*, hydnoides Cke. & Mass. *E.*, *W.*, incarnata (Pers.) Mass. *E.*, sanguinea

* See description p. 130.
† See description p. 127.

(Fr.) Bres. *T.*, *W.*, cremea* Bres. *C.*, pallidula† Bres. *W.*, subalutacea‡ (Karst.) v. H. & L., *E.* (new to Britain), longispora (Pat.) v. H. & L. *W.*

Tomentella fusca (Pers.) Schröt. *E.*, *T.*, *W.*, rubiginosa Bres. *E.*

Cyphella capula (Holmsk.) Fr. *W.*

Clavaria cinerea (Bull.) Fr. *E.*, *T. W.*, cristata (Holmsk.) Fr. *W.*, luteoalba Rea *S.*, dissipabilis Britz *S.*, persimilis Cotton *C.*

Auricularia Auricula-Judae (Linn.) Schröt. *C.*, *E.*

Exidia albida (Huds.) Bref. *C.*

Dacryomyces deliquescens (Bull.) Duby *E.*, stillatus (Nees) Fr. *C.*, *E.*

Calocera viscosa (Pers.) Fr. *W.*, cornea (Batsch) Fr. *E.*

Phallus impudicus (Linn.) Pers. *W.*, *E.*

Mutinus caninus (Huds.) Fr. *C.*

Sphaerobolus stellatus (Tode) Pers. *C.*

Lycoperdon depressum Bon. *C.*, *T.*, pyriforme (Schaeff.) Pers. *C.*, *E.*, umbrinum Pers. *T.*

Scleroderma vulgare Hornem. *T.*, *W.*, verrucosum (Vaill.) Pers. *C.*

Uromyces Poae Rabenh. *T.*

Puccinia Violae (Schum.) DC. *S.*, Malvacearum Mont. *C.*, pulverulenta Grev. *T.*, *W.*, Saniculae Grev. *E.*, Centaureae Mart. *T.*, obtegens (Link) Tul. *C.*, Cirsii Lasch. *C.*, *on Cnicus palustris*, Sonchi Roberge *T.*, *on Sonchus asper*, Menthae Pers. *C.*, obscura Schroet. *C.*, *on Bellis perennis*, Caricis (Schum.) Rebent. *C.*, *on Carex riparia.*

Coleosporium Tussilaginis (Pers.) Kleb. *C.*, *S.*, *T.*

Pucciniastrum Epilobii (Pers.) Otth. *W.*

Melampsora Larici-Caprearum Kleb. *T.*, populina Lév. *C.*, *W.*

Melampsoridium betulinum (Pers.) Kleb. *C.*, *T.*, *W.*

Urocystis Anemones (Pers.) Wint. *C.*, *T.*, *on Ranunculus repens and bulbosus.*

Sphaerotheca pannosa (Wallr.) Lév. *E.*

Podosphaera Oxyacanthae (DC.) de Bary *W.*

Erysiphe Martii Lév. *C. on Urtica dioica*, tortilis (Wallr.) Link *E.*, *on Cornus sanguinea*, Cichoracearum DC. *C. on Arctium minus and Campanula latifolia.*

Phyllactinia suffulta (Rebent.) Sacc. *T.*

Nectria cinnabarina (Tode) Fr. *C.*, sanguinea (Sibth.) Fr. *C.*, episphaeria (Tode) Fr. *C.*, Peziza (Tode) Fr. *W.*

Hypomyces aurantius (Pers.) Tul. *E.*

Claviceps microcephala (Wallr.) Fckl. *T.*, *W.*

Cordyceps ophioglossoides (Ehrh.) Link *W.*

Chaetomium elatum Kunze *S.*

* For description see p. 131.
† See p. 134.
‡ For description see p. 133.

Leptospora spermoides (Hoffm.) Fckl. *E.*, ovina (Pers.) Fckl. *C.*
Chaetosphaeria phaeostroma (Dur. & Mont.) Fckl. *W.*
Bertia moriformis (Tode) de Not. *C.*
Mycosphaerella Iridis (Auers.) Schroet. *T.*, *on dead leaves of Iris Pseudacorus.*
Ophiobolus porphyrogonus (Tode) Sacc. *C* .
Pleospora herbarum (Pers.) Rabh. *C.*, *W.*
Melanconis stilbostoma (Fr.) Tul. *E.*
Diatrypella quercina (Pers.) Nke. *T.*
Diatrype stigma (Hoffm.) de Not. *C.*
Hypoxylon multiforme Fr. *E.*, rubiginosum (Pers.) Fr. *E.*, fuscum (Pers.) Fr. *W.*, coccineum (Bull.) Fckl. *C.*
Daldinia concentrica (Bolt.) Ces. & de Not. *C.*
Ustulina vulgaris Tul. *T.*
Xylaria hypoxylon (Linn.) Grev. *C.*, *E.*
Phyllachora graminis (Pers.) Fckl. *W.*
Dothidella betulina (Fr.) Sacc. *W.*
Rhopographus Pteridis (Sow.) Wint. *T.*
Aleuria vesiculosa (Bull.) Boud. *C.*, *E.*, cerea (Sow.) Gill. *C.*
Peziza aurantia Pers. *S.*
Leucoscypha nivea (Romell) Boud. *E.*
Ciliaria scutellata (Linn.) Quél. *C.*
Cheilymenia stercorea (Pers.) Boud. *T.*, coprinaria (Cke.) Boud. *C.*
Coprobia granulata (Bull.) Boud. *C.*
Ascobolus stercorarius (Bull.) Schroet. *S.*
Exoascus turgidus Sadeb. *T.*
Ombrophila clavus (A. & S.) Cke. *T.*
Calycella citrina (Hedw.) Quél. *C.*
Coryne sarcoides (Jacq.) Tul. *W.*
Bulgaria inquinans (Pers.) Fr. *C.*
Corynella atrovirens (Pers.) Boud. *C.*
Orbilia xanthostigma Fr. *C.*, *E.*, *W.*
Sclerotinia Curreyana (Berk.) Karst. *T.*, *the sclerotium in culms of Juncus.*
Chlorosplenium aeruginosum (Oeder) de Not. *C.*
Helotium herbarum (Pers.) Fr. *C.*, *E.*
Dasyscypha virginea (Batsch) Fckl. *C.*, *E.*, nivea (Hedw. fil.) Sacc. *W.*
Trichoscypha calycina (Schum.) Boud. *T.*
Urceolella leuconica (Cke.) Boud. *T.*
Trichopeziza eriobasis (Berk.) Boud. *W.*
Mollisia cinerea (Batsch) Karst. *C.*, *E.*, *T.*, *W.*
Heterosphaeria patella (Tode) Grev. *E.*
Pseudopeziza Ranunculi (Wallr.) Fckl. *C.*
Hypoderma conigenum (Pers.) Cke. *W.*
Pilobolus crystallinus (Wiggers) Coem. *S.*

Peronospora sordida Berk. *W.*, *on leaves of Digitalis purpurea.*
Elaphomyces granulatus Fr. *W.*
Onygena corvina (A. & S.) Fr. *W.*, *on an Owl's pellet.*
Phyllosticta fraxinicola Curr. *E.*
Phoma acicola (Lév.) Sacc. *T.*, herbarum Westend. *C.*, complanata (Tode) Desm. *C.*, *W.*
Septoria Stachydis Rob. & Desm. *C.*
Cylindrium aeruginosum (Link) Lindau.
Oidium alphitoides Griff. & Maulb. *W.*
Monilia aurea Gmel. *C.*
Trichoderma lignorum (Tode) Harz. *C.*
Sepedonium chrysospermum (Bull.) Fr. *W.*
Trichothecium roseum (Link) Grev. *C.*
Ovularia obliqua (Cke.) Oud. *T.*
Ramularia Urticae Ces. *C.*, calcea (Desm.) Ces. *C.*, Knautiae (Massal.) Bub. *E.*
Torula herbarum Link *C.*
Periconia pycnospora Fres. *C.*, *S.*
Bispora monilioides Cda. *E.*
Fumago vagans Pers. *C.*
Stilbella erythrocephala (Ditmar) Lindau *W.*, fimetaria (Pers.) Lindau *C.*
Tilachlidium tomentosum (Schrad.) Lindau *W.*
Isaria farinosa (Dicks.) Fr. *T.*
Aegerita candida (Pers.) Grev. *T.*

MYCETOZOA FOUND DURING THE FUNGUS FORAY IN THE NEIGHBOURHOOD OF DONCASTER, SEPT. 22nd TO 25th, 1914.

By Gulielma Lister, F.L.S.

Our first expedition was to Cusworth Park, west of Doncaster; an old wood-yard with heaps of sawdust gave capital hunting for Mycetozoa; the park itself with open meadowland and strips of woodland lies on Magnesian Limestone, and proved to be rather dry, after the recent fine weather, for favourable results. The second day we spent in the Town Moor, Sandall Beat and Wheatley Woods, to the east of the town: the soil here was peaty and the woods consisted of Birch, Scotch Fir, Oak and some Holly, with undergrowth of Brambles and Bracken. On the third day we visited the 'New Zealand' Woods, near Medge Hall, on flats stretching away to the Humber. The trees were chiefly Birch, with some Scotch Fir and Larch; the deep peaty subsoil was intersected by broad drains. Our last day was spent in Edlington Wood, where flourished a great variety of trees, but the subsoil was Magnesian Limestone and the ground was rather too dry to favour our pursuits.

In the following list of the Mycetozoa that were found the localities visited are abbreviated as follows:—C. = Cusworth Park; S. = Sandall Beat, Town Moor and Wheatley Woods; N.Z. = New Zealand Wood; E. = Edlington Wood.

Badhamia panicea (Chev.) Rost. C. On Elm bark.

Physarum nutans Pers. C., S., N.Z., E. Very abundant on fallen wood.

P. viride (Bull.) Pers. C., S., N.Z., E. Abundant.

P. psittacinum Ditm. E. A single mouldy gathering was obtained. I have never met with this summer-loving species in good condition after August.

P. compressum Alb. & Schw. C. On dead wood.

P. cinereum Link. N.Z. On dead leaves under a heap of Birch boughs. The sporangium walls in this gathering are without lime-deposits, and the capillitium consists partly of branching *Badhamia*-like lime-knots, partly of a network of hyaline threads with wide membranous expansions; the spores measure 8·5μ to 10μ.

Such a form of *P. cinereum* is not unfrequent; in the field it bears close resemblance to *Bahamia foliicola* from which it is distinguished by the sporangia having a tendency to form plasmodiocarps and by the smaller smoother spores.

Fuligo septica (L.) Gmelin. C., S., E. Only old and weathered aethalia were obtained.

Craterium leucocephalum Ditmar S., N.Z. Fairly abundant on dead Sedge, Holly and Birch leaves. Orange-red sclerotium found on dead leaves in Cusworth Park is referable either to this species or to *C. minutum* (Leers) Fries.

Leocarpus fragilis (Dicks) Rost. S., N.Z. On Birch twigs.

Diderma effusum (Schwein.) Morg. S. On dead Sedge.

Didymium difforme (Pers.) Link. C., S., E. Abundant on old hay and living herbaceous plants in damp hollows.

D. squamulosum (Alb. & Schw.) Fries. C., S., N.Z. On dead Holly leaves and Bracken, also on weathered horse dung.

D. nigripes Fries. var. *xanthopus* Lister. On hay and hedge clippings.

D. melanospermum (Pers.) Macbr., var. *minus* Lister. S. On grass.

Stemonitis fusca Roth. C., S., N.Z. On wood.

S. flavogenita Jahn. C., N.Z. On stumps and twigs.

Comatricha nigra (Pers.) Schroet. C., S., N.Z., E. Frequent on fallen branches.

C. typhoides (Bull.) Rost. C. Weathered sporangia, on logs: var. *heterospora* Rex. S. On a Pine stump.

C. pulchella (Bab.) Rost. S. Mouldy, on dead leaves.

Cribraria aurantiaca Schrad. C., S., N.Z., E. Both the yellow and ochraceous-spored forms were obtained; the latter were very abundant on old sawdust in the Cusworth wood-yard.

C. rufa (Roth.) Rost. N.Z. On decayed Larch wood.

Dictydium cancellatum (Batsch) Macbr. C., S. Very abundant in Cusworth wood-yard, where some old logs were covered over an area of several square feet with the sporangia.

Reticularia Lycoperdon Bull. C., S. Both young and old aethalia found.

Trichia affinis de Bary. S. A few sporangia only were found on some grass stalks.

T. decipiens (Pers.) Macbr. C. On dead wood.

Hemitrichia Vesparium (Batsch) Macbr. C. The closely clustered purple sporangia and nearly black plasmodium were very abundant on the Cusworth sawdust heaps

H. intorta Lister. S. About fifty immature white sporangia were collected on fallen Pine wood, and after being kept moist for a few days matured perfectly. This rare species has hitherto been recorded only from Hitchin, Herts, and Hampstead Park, Staffordshire, in Britain; from Fairmount Park, Philadelphia, and the States of Ohio and Iowa in North America. It is closely allied to *Trichia erecta* Rex, from which it is distinguished by the sporangium-wall being shining yellow all over, not spotted with purple, and by the capillitium forming a continuous skein of twisted threads.

Arcyria denudata (L.) Sheldon. C., S., N.Z., E. On dead wood.

A. incarnata Pers. S. Sparingly found on fallen Oak boughs.

A. cinerea (Bull.) Pers. S., N.Z., E. On dead wood.

A. pomiformis (Leers) Rost. S. On fallen Oak wood.

A. nutans (Bull.) Grev. S., N.Z., E. Abundant on dead wood.

A. Oerstedtii Rost. S. On charred Pine wood. This species has not been recorded before from Yorkshire.

Perichaena depressa Libert. C., E. On Oak bark.

P. corticalis (Batsch) Rost. C. On Poplar bark.

„ var. *affinis* Lister. E. On Oak bark, associated with *P. depressa*. This variety differs from the type in having more abundant, firmer capillitium; the orange-yellow spores measure 10μ to 11μ. In the present specimen the subglobose sporangia are either brownish purple all over or are mottled with yellow, or are shining yellow all over, according to whether the dark granular deposits on the walls are continuous, or partially or completely absent. It has been recorded previously from Yorkshire and Hampshire, from the Jura Mts. and from Portugal.

This list of thirty-five species may be regarded on the whole as a fair one considering the unusually dry season we have had. After a wet summer such fine woods as those we visited would probably have been far richer in Mycetozoa.

PRESIDENTIAL ADDRESS.

By Professor A. H. Reginald Buller, D.Sc., Ph.D., F.R.S.C.

THE FUNGUS LORE OF THE GREEKS AND ROMANS.

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Edible and Poisonous Fungi.—The Dawn of Mycology.—The First Known Illustration of a Fungus.—The Rust Disease.—The Origin of Fungi.—The Sexes of Agaricum.—The Medicinal Properties of Fungi.—Origin of Poisons in Fungi.—Tests for Distinguishing between Edible and Poisonous Fungi.—Remedies for Eating Poisonous Fungi.—Attempts to Neutralize the Poisons of Fungi.—The Boletus of the Romans.—The Cultivation of Fungi.—Fire made with Fungus Tinder.—Stone Fungi.—The Fungi known to the Ancients.—The Misuse of Classical Names by Linnaeus.—Conclusion.

EDIBLE AND POISONOUS FUNGI.

The fact that some of the larger fruit-bodies of the Higher Fungi are edible whilst others are poisonous, was doubtless discovered by Prehistoric Man far back in the dim distance of the remote past, probably more than one hundred thousand years ago. Hunger and curiosity are strong motives, and either would have been sufficient to prompt our ancestors of the Stone Age to experiment on the food values of the fleshy Basidiomycetes.

There is an abundance of evidence afforded by classical literature[1] that the Greeks and Romans were well acquainted

(1) Works containing references to the classical literature of fungi are: J. J. Paulet, *Traité des Champignons,* Paris, Tome 1, 1793, pp. 1-21; H. O. Lenz, *Botanik der alten Griechen und Römer,* Gotha, 1859; C. D. Badham, *A Treatise on the Esculent Funguses of England,* London, 1863; and E. Roze in Richon and Roze, *Atlas des Champignons,* Paris, 1888. The most systematic collection of references in the English language is that made by W. Houghton called *Notices of Fungi in Greek and Latin Authors,* Annals and Magazine of Natural History, Series 5, Vol. 15, 1885, pp. 22-49. Of the materials gathered together in this excellent paper and of the translations I have made free use; but in addition I have referred to a number of passages in the Classics which Houghton did not mention. Except where otherwise stated, all references given in this chapter have been verified from the original sources, and where it has been found necessary, revised translations have been given. In the work of translation, I have had the invaluable help of my friend, Mr. W. B. Grove, who is both a mycologist and a master of the classical languages. My colleague, Frederick W. Clark, Professor of Greek and Latin, has also been good enough to read over my manuscript and to give me the benefit of his criticism.

with the gastronomic qualities of such fungi as Truffles, Boleti (our Amanitae), Puff-balls, and Mushrooms. Indeed, in their days of luxury, the wealthy Romans seem to have developed a passion for these delicacies. Thus Pliny,[2] in his observations on the cooking of fungi, remarks that fungi are "the only food which dainty voluptuaries themselves prepare with their own hands and thus, as it were, by anticipation feed on them, using amber knives and silver service"; whilst Juvenal's contempt for the practice is shown in one of his Satires,[3] in which he says: "Nor will that youth allow any relative to hope better of him who has learnt to peel truffles and to pickle boleti." Special vessels for cooking boleti were known as *boletaria*, and these were not supposed to be used for any inferior purposes. Martial,[4] in an Epigram, represents one of these vessels as lamenting its changed function in a Roman kitchen: "Although boleti have given me so noble a name, I am now used, I am ashamed to say, for Brussels sprouts." In another Epigram, the same poet[5] says: "Gold and silver and dresses may be trusted to a messenger but not boleti." Obviously, one is to infer that on the way the fungi might prove too great a temptation and the man might cook them and eat them. Suetonius[6] states that the emperor Tiberius gave Asellius Sabinus 200,000 sesterces (*circa* £2,000) for composing a dialogue in which boleti, beccaficos, oysters, and thrushes were represented as contending for the honour of being the best food. Coelius Apicius,[7] in his work called *De Arte Coquinaria Libri Decem*, in discoursing upon the arts of the kitchen, tells us how Boleti, Tubera, and other fungi may be cooked. It is evident from his recipes that diverse condiments were often added to the dishes.

(2) Pliny, Natural History, Delphin. ed., XXII., 47.
(3) Juvenal, Sat. XIV., 6-8.
(4) Martial, Ep. XIV., 101.
(5) *Ibid.* XIII., 48.
(6) Suetonius, Tib. cap. XLII. Beccaficos are small birds much esteemed as dainties in the autumn when they have fattened on figs and grapes. *Vide* Murray's English Dictionary.
(7) Coelius Apicius, De Opsoniis et Condimentis, sive de Arte Coquinaria Libri Decem, ed. 2, by Martin Lister, 1719, pp. 208-211. It is believed that the original work was compiled in the third century A.D. (Encyclopaedia Britannica, article Apicius).

Apicius mentions four different kinds of fungi as being prepared for the table: *Fungi farnei* (conjectured by some to be our *Boletus edulis*); *Boleti* (our *Amanita caesarea*); *Tubera* (Truffles); and *Sfonduli, Funguli,* or *Spongioli* (believed to correspond to the *Spongiole* of Porta, 1592, and the modern Italian *Spugnola,* the name of *Morchella*). The following are the recipes as translated by Houghton from the edition of C. T. Schuch, 1874, pp. 154-156 (Houghton, *loc. cit.,* p. 47. I have altered the word *peel* to *slice* in the first recipe for Tubera in deference to a criticism by Tulasne in his *Fungi hypogaei*).

For cooking *Fungi farnei:* (1) Boil them, dry hot, and serve with wine-sauce *(oenogarum)* and pepper pounded with liquor. (2) Use

The practice of giving extravagant banquets grew to such an extent at a late period of the Roman Republic that from time to time sumptuary laws were passed to prevent the use of certain expensive articles of animal diet. But no restrictions were placed upon the products of the soil. The result was, as Cicero[8] tells us, that those fond of the table devised means of cooking vegetable food so as to make it as tasty as possible. He says: "While these elegant eaters wish to bring into high repute the products of the soil which are not included in the Act, they prepare their fungi, helvellae, and all vegetables with such highly seasoned condiments that it is impossible to conceive anything more delicious." Cicero also says that in his own case the law proved to be a fraud, for, after partaking of some of these dishes at a supper given by the augurs at the house of Lentulus, he was seized with such violent diarrhœa that for ten days he was hardly able to stand. He had abstained from oysters and eels in obedience to the law, but not from highly seasoned vegetables: "I who willingly abstained from delicate fishes, found myself taken in by vulgar herbs." He ends his letter with a reflection which many another has made under like circumstances: "After this I shall be more cautious." The passing of the sumptuary laws was probably one of the reasons why the eating of fungi became so popular in the time of the Roman Emperors.

Some of the rich Greeks appear to have been just as fond of the luxuries of the table as the Romans, for Plutarch,[9] in his

pepper, sweet boiled wine *(caroenum)*, vinegar, and oil. (3) Another recipe: boil in salt and serve with oil, wine, and pounded coriander seed.

For *Boleti:* (1) Pour over them sweet boiled wine and add a bunch of green coriander and serve. (2) Another recipe: serve their stalks in liquor with salt. (3) Place the cut-off stalks *(tirsos)* on a dish, pour echinus eggs (?) *(uvam)* over them with pepper, lovage, a little honey, and oil.

For *Tubera:* (1) Slice, boil, sprinkle with salt, and transfix with a twig *(surculo infigis)*; partly roast, and place in a cooking-vessel with oil, liquor, sweet boiled wine, unmixed wine, pepper and honey; while boiling, beat up with fine flour, take out the twigs and serve. (2) Another recipe: boil and sprinkle salt, transfix with twigs, partly roast, place in a cooking-vessel with liquor, oil, greens, sweet boiled wine, a small quantity of unmixed wine, pepper, and a little honey, and let it boil; while boiling beat up with fine flour; prick the tubers that they may absorb, take out the twigs and serve. If you like you may surround the tubers with the omentum of a pig, then roast and serve.

Four other recipes for cooking Truffles are given, the ingredients not mentioned in the above recipes being mint, rue, leeks (?), cummin, seseli, and parsley. Apicius gives several recipes for cooking *Spongioli (Morchella)* which do not differ in any particulars from those he gives for serving *Fungi farnei* (*vide* p. 65 of Schluch's edition).

(8) Cicero, Ad. Fam. VII., 26. Letter to Gallus.

(9) Plutarch, De Tuenda Sanitate Praecepta, Vol. II., p. 124, F_2 ed. Xylander; *cf.* also the translation of Plutarch's Works, published by T. V. Crowell and Co., Vol. V., Rules for the Preservation of Health, p. 602.

Rules for the Preservation of Health, discourses upon the folly of the former in indulging in costly meats and drinks. He particularly mentions as articles of luxury: "sow's udders, Italian mushrooms (*μυκήτων 'Ιταλικῶν*), Samian cakes, and snow in Egypt."[10] The use of the expression "Italian mushrooms" warrants us in believing that edible fungi were sometimes exported from Italy into Greece.

The tragic consequences which may sometimes result from the accidental eating of poisonous species of fungi, were as well known to the old Greeks and Romans as to ourselves. Thus, according to Eparchides,[11] when Euripides (480-406 B.C.) was on a visit to Icarus, a certain woman, with two full-grown sons and an unmarried daughter, gathered some deadly fungi from the fields, and all the family partook of them and died. Whereupon, the poet made the following Epigram: "O Sun, that cleavest the undying vault of heaven, hast thou ever seen with thine eye such a calamity as this—a mother and maiden daughter and two sons destroyed by pitiless fate in one day?"

Hippocrates[12] (born *circa* 460 B.C.), the Father of Medicine, relates that the daughter of Pausanias, having eaten a raw fungus, was seized with nausea, suffocation, and pains in the stomach. She was given hydromel to drink and was put into a hot bath. In the bath she vomited up the fungus, and, as the trouble passed off, perspired profusely.

To the poet Martial[13] is attributed an Epigram on the death of Macrinus in which there are two rather grim puns on the names of fungi:

Defungi fungis homines, Macrine, negabas;
Boleti leti causa fuere tui.

(10) Houghton and others read "snow *from* Egypt." This is a wrong translation. Snow does not fall in Egypt, but compressed snow or ice might have been brought there sometimes from the mountains of Asia Minor or Southern Europe.

(11) Eparchides, *apud* Athenaeus, Deipnosoph. II., 57.

(12) Hippocrates, Epidemicorum, lib. VII., §102. The patient of Hippocrates may have eaten the fungus raw through thoughtlessness or ignorance. It was usual for the Greeks and Romans, as we learn from the writings of Pliny, Apicius, etc., to cook their fungi. Truffles, however, were an exception, for Dioscorides (Mat. Med. II., 174, *sec.* Houghton) tells us that these were eaten "either raw or cooked." At the present day, fungi are universally cooked by civilized people. However, according to Charles Darwin, the Fuegians of Patagonia sustain themselves on *Cyttaria Darwinii* (one of the Pezizineae), which they devour in the raw state. Darwin says that this fungus "has a mucilaginous, slightly sweetish taste, with a faint smell like that of a mushroom," and remarks that, so far as he knows, "Tierra del Fuego is the only country in the world where a cryptogamic plant affords a staple article of food" (Journal of Researches During the Voyage of H.M.S. "Beagle," Chap. XI.).

(13) *Vide* Martial, ed. Delphin., Vol. II., p. 1074.

"You were wont to deny, Macrinus, that men could be killed by fungi; yet Boleti were the cause of your own death."

Harmless fungi were sometimes made the instruments of the vilest deeds. The most celebrated instance is the murder of Claudius Cæsar by his wife Agrippina, which, according to Pliny,[14] Suetonius,[15] and Tacitus,[16] was accomplished by adding poison to a dish of edible Boleti[17] of which the unsuspecting Emperor partook. Some said that the poison was prepared by Locusta and others that it was placed in the dish by Agrippina's own hands. Claudius, after his death, was deified, notwithstanding that by violent deeds he had rendered himself an object of loathing to the people. In the sarcastic words of Juvenal, "he descended into heaven."[18] Nero, who succeeded him and was doubtless privy to the plot, was audacious enough to make no secret of the manner in which Claudius had been poisoned; for, quoting a Greek proverb *(Βρῶμα Θεῶν)*, he used to declare that Boleti were *food of the gods*. This was obviously a joking allusion to the apotheosis of his predecessor.[19]

Again, Pliny[20] states that the Suilli (probably *Boletus edulis*) are very convenient for poisoning (venenis accommodatissimi), and as he adds that they caused the death of Annaeus Serenus, the prefect of Nero's guard, together with a number of tribunes and centurions at a banquet, it seems likely that the fungus was used as a medium for introducing some poison of a foreign nature into the dish in which it appeared at table.[21]

Fungi were divided into edible and poisonous kinds by Dioscorides,[22] the celebrated Greek writer on medicine, who lived in the first century A.D. This gastronomic system of classification was followed by many of the Herbalists whose first works were simply commentaries upon Dioscorides. Owing to its popular appeal and practical utility, it has survived to the present day and is now embodied in scores of books published in various languages.

The leading authorities on medicine among the ancients looked upon the consumption of fungi with grave suspicion; firstly, because they knew of so many cases of accidental

(14) Pliny, Nat. Hist., XXII., 46.
(15) Suetonius, Claudius, 44.
(16) Tacitus, Annals, Translation by Church and Brodribb, 1906, Book XII., 66 and 67.
(17) Most probably our *Amanita caesarea, vide infra.*
(18) Juvenal, Sat. VI., 622-623.
(19) Suetonius, Nero, §33. For the Greek proverb *cf.* Houghton, *loc. cit.*, p. 37.
(20) Pliny, Nat. Hist., XXII., 47.
(21) *Cf.* Houghton, *loc. cit.*, p. 33, where this view is discussed at length.
(22) Dioscorides, Mat. Med., IV., 83.

poisoning, and, secondly, because the edible kinds were often eaten to such excess that they gave their patients indigestion. Dioscorides stated that even the good kinds "if partaken of too freely, are injurious, being indigestible, causing stricture and cholera," and he suggested that an emetic should be taken after the meal of which they formed a part.[23] He would have applauded Pliny's question "What so great pleasure can there be in such doubtful food?"[24] Galen (born A.D. 130), whose opinions on medicine became so celebrated in after years and who was so often quoted by the Herbalists of the sixteenth and seventeenth centuries, treated of fungi from the strictly medical point of view. He held that fungi in general are unwholesome, and deprecated their consumption. He advised people not to touch anything but the Boletus *(Amanita caesarea)* and the Amanita *(Psalliota campestris)*, and even concerning the former, notwithstanding the popular verdict, he had nothing good to say. These are his words: "Of fungi *(μύκης)* the Boletus *(βωλίτης)*, when well boiled, must be counted among insipid things; it is generally eaten with various kinds of spices, as is done with other insipid food. These fungi, after being eaten in large quantities, yield cold, clammy, noxious juices as their nourishing qualities; the Boleti are the most harmless, and after them the Amanitae *(ἀμανῖται)*; as for the rest, it is far safer to have nothing to do with them."[25] In his work on *The Good and Bad Juices of Foods*, he says: "Of all such kinds of food, fungi have the coldest, most viscid, and thickest juice; however, among them the Boleti have never been known to cause anyone's death; still, to some persons, even they cause cholera and indigestion."[26] Notwithstanding all these words of wisdom and the weight of Galen's authority, the public was not prepared to forego the pleasure of eating various kinds of fungi. The later works of Athenaeus[27] and Diphilus[28] inform us that, in the second and third centuries A.D., cases of fungus-poisoning still continued to occur, and that there were still folks who ate of the edible sorts so immoderately that they were punished with all the pangs of indigestion.

THE DAWN OF MYCOLOGY.

It seems natural enough that the first interest of man in fungi should have been connected with his food supply. However, as civilization advanced, men began to reflect upon

(23) Dioscorides, *Ibid.*
(24) Pliny, Nat. Hist. XXII., 47.
(25) Galen, De Aliment. Facult., lib. II., 69.
(26) Galen, De Probis Pravisque Alimentorum Succis, *cap.* IV., p. 770.
(27) Athenaeus, Deipnosoph. II.
(28) Diphilus is quoted by Athenaeus, *loc. cit.* II., 61, d.

and to discuss the nature of plants and animals from a more detached standpoint. Thus Solomon, who reigned from about 971-931 B.C., "spake of trees from the cedar tree that is in Lebanon even unto the hyssop that springeth out of the wall; he spake also of beasts and of fowl, and of creeping things, and of fishes."[29] The "kings of the earth" came to hear his wisdom, but as to whether or not his discourses included fungi, we have no evidence.[30]

The first references to fungi in classical literature were made in the fifth century B.C., and are those of Euripides and Hippocrates, each of whom, as we have seen, record a case of accidental poisoning, the one from the point of view of a poet and the other from that of a medical man. In addition, however, Hippocrates mentions that fungi (probably *amadou*, the German tinder of commerce) were used for cauterization in certain complaints. To this matter we shall return in a later section.[31]

The first philosophical reflections on the nature of fungi are those of Theophrastus, the famous pupil of Aristotle (*circa* B.C. 300). Unfortunately he seems to have assumed that his readers were well acquainted with the species to which he was referring, and he has therefore not described his fungi sufficiently for identification. He[32] speaks of the *μύκης* and the *ὕδνον* as having neither root, stem *(καυλός)*, branch, bud, leaf, flower, nor fruit; again neither bark, pith, fibres, nor veins. Later, however,[33] he speaks of the stem *(καυλός)* of the *μύκης* as having a certain uniform structure or evenness. He[34] also says that the *ὕδνον*, *μύκης*, *πέζις*, and *κεραύνιον* have no root. He[35] adds that the *μύκητες* grow out of and near the roots of oaks and other trees, and, in his treatise on odours, notes[36] that the *μύκητες* which grow on dung have no bad smell. Evidently, Theophrastus, finding

(29) Solomon, I Kings IV., 33.

(30) Indirect references to fungi not improbably are to be found in Leviticus, chaps. XIII. and XIV. It seems likely that the leprosy which caused baldness of the head and beard, was brought about by a parasitic fungus. The leprosy of the house may have been caused by *Merulius lacrymans* or some other wood-destroying fungus; but the evidence on this point, in my judgment, is not very clear. The phrase "hollow strakes, greenish or reddish," does not seem applicable to *Merulius lacrymans*. The blight of corn, mentioned several times in the Old Testament, may have been due to a Rust fungus (*Cf.* Eriksson und Henning, Die Getreideroste, ihre Geschichte, etc., Stockholm, 1896). There is no reference in the Bible to such fungi as Mushrooms and Truffles.

(31) *Vide infra:* "Fire Made with Fungus Tinder," p. 46.

(32) Theophrastus, Hist. Plant., I., 1, §11, ed. Teubner.

(33) *Ibid.* I., 5, §3.

(34) *Ibid.* I., 6, §5.

(35) *Ibid.* III., 7, §6.

(36) Theophrastus, De Odoribus, Frag. IV., 1, §3, ed. Teubner

that the Fleshy Fungi are so different in appearance from the Higher Plants, was puzzled to give them a description, and solved the problem by setting out a list of negative characters. These first recorded observations on the nature of fungi, few though they are, may be considered as registering the beginning of the study of the morphology of fungi and the dawn of mycology.

In order to find out what the fungi are which Theophrastus mentions, it is necessary to compare what later Greek and Roman writers, such as Pliny and Athenaeus, say about them. As a result of proceeding in this way, the conclusion has been arrived at that *μύκης* was the Greek name for fungi in general excluding Truffles; that *ὕδνον* was the general name for Truffles *(Tubera);* that *κεραύνιον* was a particular kind of Truffle; while *πέζις* was the name for a Puff-ball, possibly of *Lycoperdon Bovista* Linn.[37] It is not unlikely that the fungi *(μύκητες)* which "grow on dung" and "have no bad smell' were fruit-bodies of *Psalliota campestris,* the Common Mushroom, for these are easily observed when they come up on stable manure, and possess a distinctly pleasant odour. On the other hand, the philosopher may have had in mind the common coprophilous species of *Coprinus* and *Panaeolus.*

There can be no doubt that the Romans considered fungi as among the commonest objects of life long before the beginning of the Christian era. This is proved by the fact that Plautus, the great comic dramatist of ancient Rome, who flourished at the end of the Third Century B.C., refers to fungi in the colloquies of his plays in the most familiar manner. Thus, in his *Trinummus,* when old Charmides, without being seen, has observed the entrance of the sycophant who wears a hat with a very broad brim, he makes Charmides exclaim: "By Pollux, he's just like an Agaric: he's completely covered by his head!"[38] The slave Sangarinus is made to say, in his last speech in the *Stichus,* that it is just as impossible for him to have too much dancing as it is for a mushroom to have too much rain.[39] Further, in the *Bacchides,* in the fourth act, Plautus makes the slave Chrysalus ridicule his old master Nicobulus. Chrysalus says: "He has been travelling up and down this earth, a perfect nuisance; he has neither sense nor

(37) *Cf.* Lenz, *loc. cit.,* p. 755; and Houghton, *loc. cit.* pp. 43, 48, etc. *Vide infra.*

(38) Plautus, Scriptorum Classicorum Bibliotheca Oxoniensis, Oxonii, Comoediae, Trinummus, IV., 2, 9: "Pol hicquidem fungino generest: capite se totum tegit."

(39) Plautus, *loc. cit.,* Stichus, V., 7, 5-6: "Nunc pariter ambo. Omnis uoco cinaedos contra. | Satis esse nobis non magis poti' quam fungo imber."

feeling; he's no more good than a rotten fungus!"[40] In the second act, Nicobulus complains to Chrysalus of Archidemides, and says *not* "Wasn't I a *fool* to trust him!" *but* "Wasn't I a *fungus* to trust him!";[41] and, in the fifth act, in a burst of self-denunciation, he says: "Of all the persons here in the world or already dead or yet to be born, who are fools, blockheads, idiots, *fungi*, dullards, drivellers, and babblers, I, quite by myself, surpass them all in my folly!"[42] Evidently the word *fungus*, like the word ass with us had come to be used in a derisive sense.[43]

THE FIRST KNOWN ILLUSTRATION OF A FUNGUS.

To the Romans we must go back for the first illustration of a fungus which has come down to us. In the first year of the reign of Titus, 79 A.D., occurred the famous eruption of Vesuvius which buried Herculaneum and Pompeii in lava and ashes, and thus preserved to us so many precious relics of Roman civilization. Excavations in Pompeii have brought to light, on the walls of public and private buildings, some 2,000 frescoes, of which a certain number represent people, objects, and scenes in the immediate neighbourhood. Into these mural decorations, plants were sometimes introduced. Most of them are Phanerogamia, but in one picture there are several fruit-bodies of one of the Agaricineae. Comes, who wrote a book on the plants depicted at Pompeii, has identified the fungus as *Lactarius deliciosus*. Comes also holds that this species is the one referred to by Pliny where he says that "the safest fungi are those whose skin becomes red, but a less dilute red than that of the Boleti (fungorum . . . . tutissimi, qui rubent callo, minus diluto rubore quam boleti)."[44]

(40) Plautus, *loc. cit.*, Bacchides, IV., 7, 23-24: "Terrae (iam) odium ambulat; iam nil sapit, | Nec sentit; tanti 'st quanti 'st fungus putidus."

(41) Plautus, *ibid.* II., 3, 49: "Adeon me fuisse fungum ut qui illi crederem."

(42) Plautus, *ibid.* V., 1, 1-2: "Quiquomque ubi sunt, qui fuerunt quique futuri sunt posthac | Stulti, stolidi, fatui, fungi, bardi, blenni, buccones, | Solus ego omnis longe antideo stultitia et moribus indoctis."

(43) There is another possible reference in Plautus to fungi, namely, in the *Curculio*, V., 2, 13-14, in which Therapontigonus says to the Parasite: "Quin tu is in malam crucem | Cum bolis, cum bullis?" *Cum bolis, cum bullis* is the reading in the Oxford edition. According to Roze (*loc. cit.* p. V.), this was the reading of Robert-Estienne in 1530; but Lambin in 1576 read *cum boletis, cum bulbis*, a version adopted by Naudet. If this latter reading could be relied on, it would afford evidence that the famous *boletus (Amanita caesarea)* was known long prior to the time of Pliny.

(44) O. Comes, Illustratione delle piante nei dipinti pompeiani, Napoli, 1879, p. 9. According to Comes, the fruit-bodies are represented in the painting No. 102 of the Museo nazionale, and this painting is reproduced in the *Pitture di Ercolano e contorni*, Napoli, 1757, Vol. II, t. 56. Another reproduction is given by E. Saglio in the article on *Cibaria*, Dictionnaire des Antiquités, Grecques et Romaines, Paris, now in course of publication. Seven or eight fruit-bodies are shown lying together after being picked. The sketch is in black-and-white,

THE RUST DISEASE.

Doubtless the cultivated plants of the Greeks and Romans often suffered from diseases which must have seemed highly mysterious in their origin. Among these diseases was certainly the Red Rust of Wheat and other cereals, for mention is made of it by Aristotle, Theophrastus, Strabo, Varro, Columella, Ovid, and Pliny.[45] Pliny several times refers to Rust, which in one passage he calls "the greatest pest of the crops."[46] He tells us that many people say that it is caused by the sun heating the dew, but he gives it as his opinion that it is produced by frost.[47] He further says that Rust is averted "by fixing branches of laurel in the fields, for then the Rust passes over to the laurel leaves."[48] It is difficult to imagine what could have led to this useless practice.

The Romans had a festival every Spring called the Robigalia (Rubigalia), which was celebrated for the purpose of warding off the *robigo* (rad. *robus=ruber*, red), which was the Latin name for Rust. Pliny says: "The ancients feared three periods of the year for their crops, on account of which they instituted feasts, the Rubigalia, the Floralia, and the Vinalia. The Rubigalia were instituted by Numa in the eleventh year of his reign, and they are now celebrated on the twenty-fifth of April, since at that time the Rust generally attacks the corn."[49] The object of the Robigalia was to propitiate the god Robigus, who was supposed to have the power of warding off the Rust disease. The Quirinal flamen presided over the ceremony, and the procession marched out from Rome to the *lucus Robigi*, situated at the fifth milestone along the Claudian way. There in the sacred grove, before a crowd clad in white togas, the priest offered up a prayer to the stern Rust-god, imploring him to spare the crops of Ceres, a libation of wine was poured upon the altar, incense was thrown into the flames, and the entrails of a sheep and of a dog were placed on the altar and burnt.[50] The dog was reddish,[51] this colour being symbolical of the pest to be averted.[52] Ovid, once, when returning to the capital from the neighbouring town of

(45) *Cf.* Eriksson und Henning, Die Getreideroste, Stockholm, 1896, pp. 7-11.
(46) Pliny, Nat. Hist., XVIII., 46.
(47) *Ibid.* XVIII., 68.
(48) *Ibid.* XVIII., 46.
(49) Pliny, Nat. Hist., XVIII., 69.
(50) Ovid, Fasti, IV., 905.
(51) Festus, ed Müller, p. 285 (*sec.* Fowler): "Rufae canes immolabantur, ut fruges flavescentes ad maturitatem perducerentur."
(52) This is the view of Mannhardt. Frazer says that the colour of the dog was supposed to resemble not the Red Rust but the corn which it was desired to bring to its golden perfection. Fowler says either or both of these views may be correct. *Vide* A. W. Fowler, The Roman Festivals of the Period of the Republic, London, 1899, p. 91.

Nomentum, met the Robigalian procession by chance, and it is to his pen that we are indebted for an account of the rites which were performed by the priest.[53] To-day, the children of men still worship many strange gods; but Robigus, the stern Rust-god, is not among them. The besom of science has stretched even to high Olympus and has ruthlessly swept him into the dust-bin of oblivion.

THE ORIGIN OF FUNGI.

Concerning the origin of fungi, the Greeks and Romans entertained only the vaguest ideas. In particular, the coming into existence of Truffles seemed to be one of the marvels of nature. Of course the mycelium which we now know gives rise to them, must usually have escaped notice and, even if observed, its function could scarcely have been suspected. Pliny[54] says: "Among the most wonderful of all things is the fact that anything can spring up and live without a root. These are called Truffles (tubera); they are surrounded on all sides by earth, and are supported by no fibres or only by hair-like root-threads (capillamentis); nor does the place in which they are produced swell out into any protuberance or present any fissure; they do not adhere to the earth; they are surrounded by a bark, so that one cannot say they are altogether composed of earth, but are a kind of earthy concretion; they generally grow in dry sandy places which are overgrown with shrubs; in size they are often as large as quinces, and weigh as much as a pound. There are two kinds: one is sandy and injures the teeth, the other is without any foreign matter (sincera); they are distinguished by their colours being red, or black, or white within; those of Africa are most esteemed. Now whether this imperfection of the earth (vitium terrae)—for it cannot be said to be anything else—grows, or whether it has at once assumed its full globular size, whether it lives or not, are matters which I think cannot be easily understood. In their being liable to become rotten, these things resemble wood."

One of the opinions current among the ancients was that Truffles are formed during thunderstorms. The pages of Plutarch[55] contain a long and curious dissertation on the question: "Why Truffles are thought to be produced by thunder." At a supper in Elis, some very large Truffles were set upon the table. After everybody had admired them, one

(53) For other references to the Robigalia *cf.* the article on *Robigalia* by J. Hild in the *Dictionnaire des Antiquités Grecques et Romaines*, Paris, now in course of publication.

(54) Pliny, Nat. Hist., XIX., 11.

(55) Plutarch, Symposiaca (Table Talk), Book IV., Question 2. *Cf.* The Complete Works of Plutarch, T. Y. Crowell and Co., New York, Vol. VI., pp. 215-217; also Houghton, *loc. cit.*, p. 45.

of the guests remarked with a smile: "These are worthy of the late thunder," thereby meaning to deride those who think that Truffles are produced by thunder. This precipitated a general discussion on the origin of Truffles. The host Agemachus stood up stoutly for the generally accepted opinion, and in ending his defence said: "It is absurd to wonder at these things when we see the most incredible things imaginable in thunder, as flame arising out of moist vapour and from soft clouds such deafening noises." The view finally accepted was that Truffles grow by means of a certain generating fluid *(ὕδωρ γόνιμον)* contained in the thunder, which being mixed with heat, pierces into the earth and there produces the tubera. It was also held that Truffles do not resemble plants, and although they are nourished by rain, nevertheless have neither root nor shoot, and are quite free and independent, the earth having been altered and changed in substance. Juvenal[56] also refers to the influence of thunderstorms on Truffles in the description of a feast, in which he says: "Before him there smokes the liver of a big goose, fit to be eaten by geese, and a boar's head, worthy of the sword of the yellow-haired Meleager. After this Truffles will be handed round if it is spring and if the longed-for thunders have produced the precious dainties."

From some remarks of Theophrastus[57] (*circa* 300 B.C.), it appears that in his time not all the Greeks were content with the belief that Truffles are produced by thunder. He says: "With regard to these things, peculiar beliefs are held, for they say that they are produced during autumn rains, and thunderstorms especially, which are the main reason of their growing, and that they do not last more than a year, and are best for food in the spring. Some think they are produced from seed, because those which grow on the shore of the Mityleneans only appear after floods, which bring down the seed from Tiarae, where many *ὕδνα* are found. They grow on the shore where there is much sand. They are found around Lampsacum of Abarnis, and in Alopeconnesus (Asia), and in Elis." In this passage, we find the first reference to seeds as the possible origin of fungi. There is not the slightest reason, however, to believe that the ancients thought that fungi in general arise from seeds. We are safe in supposing that Phanias, who wrote a book on plants, represented the opinion of his day when he stated that Fungi *(μύκης)* and Truffles *(ὕδνον)* are like Ferns *(πτερίς)* in that "they produce neither bloom nor any trace of generation by buds or seeds."[58]

(56) Juvenal, Sat. V., 116-119.

(57) Theophrastus, Hist. Plant., I., 6, §13, ed. Schneider, *sec.* Houghton. This passage is quoted in Athenaeus, Deipnosoph., II., 62, b, c.

(58) Phanias was one of the writers quoted by Athenaeus, A.D. 230 (Deipnosoph. II., 56-59).

That the Greeks and Romans took notice of the lamellae of the Agaricineae is shown by the fact that they mistook certain simple corals which have radiating calcareous plates, for fungi turned to stone;[59] but there is nothing to suggest that the ancients ever observed the spore-dust which the hymenium gives forth. Doubtless it was nothing more than a witty sally when Petronius,[60] in his Satyricon, in describing the extravagant tastes of the gourmand Trimalchio, said that the latter had written to India in order to have some seed of the Boletus sent to him.

The physician and poet Nicander (*circa* 185 B.C.) refers to a fungus as being "the evil ferment of the earth." The following translation from his hexameter poem called the *Alexipharmaca*, in which he treats of poisons and their antidotes, will serve to show how fact and fable mingled in his mind.[61] "Let not the evil ferment of the earth which often causes swellings in the belly or strictures in the throat, distress a man; for when it has grown up under the viper's deep hollow track, it gives forth the poison and hard breathing of its mouth; an evil ferment is that; men generally call the ferment by the name of fungus (*μύκης*), but different kinds are distinguished by different names; but do thou take the many-coated heads of the cabbage, or cut round the twisting stems of the rue, or take the efflorescence which has accumulated on old corroded copper, or steep the ashes of clematis in vinegar, then bruise the roots of pyrethrum, adding a sprinkling of dye or soda, and the leaf of cress which grows in gardens, with the medic plant and pungent mustard, and burn wine-lees or the dung of the domestic fowl into ashes; then, putting your right finger in your throat to make you sick, vomit forth the baneful pest."

THE SEXES OF AGARICUM.

Dioscorides[62] speaks of certain fungi as differing in sex. Thus in discussing the Agaricum, to which he attributed important medicinal properties, he says: "One kind is male, the other female, which differs from the male in having straight fibres within: the male is roundish in form and of the same texture throughout; in taste both kinds are similar, at first sweet, then, after being in the mouth a little time, bitter. It grows in Agaria of Sarmatia; some people say that it is the root of a plant, others that it is produced like fungi (*μύκητες*) in the trunks of trees that have become rotten; it grows also

(59) We owe this interesting deduction to Houghton, *loc. cit.* p. 41. *Cf.* the later section on "Stone Fungi."
(60) Petronius, Cena Trimalchionis, 38. *Cf.* Petronius (Trimalchio's Banquet), translation by M. J. Ryan, Scott Publishing Company, p. 14.
(61) Nicander, Alexipharmaca, 521-536.
(62) Dioscorides, De Med., III., 1.

in Asia, namely in Galatia and Cilicia, on cedar trees, but it is of a friable and weak nature." From the description of Dioscorides, it seems reasonable to believe that his female Agaricum corresponds to the *Polyporus officinalis* of the old pharmacopoeias and of modern mycology.[63] This fungus, according to Fries,[64] grows on larches in subalpine places in Southern Europe. The "straight fibres within" were doubtless the hymenial tubes. But what was the male Agaricum which was "roundish in form and of the same texture throughout"? Evidently, Dioscorides had but a very imperfect idea of the nature of the Agaricum, or he would not have mentioned that some people regard it as a root and others as a fungus; and he may not have been aware that the plant existed in two forms, that freshly gathered and that prepared for commerce. Commercial Agaricum, according to Paulet,[65] used to consist of fruit-bodies with the upper scaly crust and the lower layer of hymenial tubes removed, i.e., of the homogeneous sporophore flesh only. It seems likely, therefore, that the male Agaricum of Dioscorides was simply the fruit-body of *Polyporus officinalis* in the commercial state,[66] and that the two forms of Agaricum were called male and female simply as a means of distinguishing them.[67] On this view the supposition that in the first century of the Christian era it was believed that certain fungi interacted in some way so as to bring about sexual reproduction, may be dismissed from our minds.

(63) There are several synonyms for this fungus. After the reform of nomenclature by Linnaeus in his *Species Plantarum* of 1753, it was called *Boletus Laricis* Jacq. in 1778; *Boletus officinalis* Vill. in 1789; *Boletus purgans* Pers. in 1801; and *Polyporus officinalis* Fr. in 1821. With the introduction by Gillet in 1878 of the generic name Fomes for perennial species of Polyporus, the *Polyporus officinalis* Fr. became converted into *Fomes officinalis*. The American, Murrill, who wrote his systematic account of the Polyporaceae shortly before the rules of fungus nomenclature were formulated at an international congress at Brussels in 1910, goes back beyond Fries to the earliest specific name of the Linnaean type and calls the fungus *Fomes Laricis* (Jacq.) Murrill (*Cf.* W. A. Murrill, North American Flora, Vol. IX., p. 99).

(64) Fries, Hymenomycetes Europaei, Upsaliae, 1874, p. 555. In North America the fungus is found on a number of conifers in a region extending from New Mexico to Canada. It occurs on several species of Pine (*Pinus ponderosa, P. murrayana, P. lambertiana*), on the Douglas Spruce (*Pseudotsuga taxifolia*), and on the Larch (*Larix occidentalis*). *Vide* G. G. Hedgcock, Notes on some Diseases of Trees in our National Forests, Washington, 1914, p. 2.

(65) Paulet. Traité des Champignons, Paris, Tome I., 1793, pp. 10 and 501.

(66) *Cf.* Paulet, *loc. cit.*

(67) The sex names *mas* and *femina* were frequently employed before the time of Linnaeus for distinguishing between allied species. Linnaeus himself, in his *Philosophia Botanica* (1751, p. 214), protested against this erroneous nomenclature. At the same time he gave a list of twenty-one genera (Filix, Orchis, Veronica, etc.) in which it had been used. The popular names *Lady Fern* and *Male Fern* still serve to distinguish two distinct species.

THE MEDICINAL PROPERTIES OF FUNGI.

Dioscorides evidently believed that the Agaricum was a most powerful agency in curing disease. Continuing the passage quoted in the foregoing paragraph, we find that the fungus is endowed with the most astonishing medicinal virtues: "Its properties are styptic and heat-producing, efficacious against colic *(στρόφους)* and sores, fractured limbs, and bruises from falls; the dose is two obols weight with wine and honey to those who have no fever; in fever cases with honeyed water; it is given in liver complaints, asthma, jaundice, dysentery, kidney diseases where there is difficulty in passing water, in cases of hysteria, and to those of a sallow complexion, in doses of one drachma; in cases of phthisis it is administered in raisin-wine, in affections of the spleen with honey and vinegar. By persons troubled with pains in the stomach and by those who suffer from acid eructations, the root is chewed and swallowed by itself without any liquid; it stops bleeding when taken with water in three-obol doses; it is good for pains in the loins and joints, in epilepsy when taken with an equal quantity of honey and vinegar; it assists menstruation and relieves flatulence in women when taken with equal proportions of honey and vinegar. It prevents rigor if taken before the attack; in one- and two-drachma doses, it acts as a purgative when taken with honeyed water; it is an antidote in poisons in one-drachma doses with dilute wine. In three-obol doses with wine it is a relief in cases of bites and wounds caused by serpents. On the whole, it is serviceable in all internal complaints when taken according to the age and strength of the patient; some should take it with water, others with wine, and others with vinegar and honey or with water and honey."

The Agaricum was not the only fungus believed by the ancients to possess medicinal properties, as may be learnt from the remarks of Pliny[68] about the *Suilli*, which several writers, *e.g.*, Paulet,[69] Lenz,[70] and Houghton,[71] have identified with our *Boletus edulis:* "Glaucias thinks that Boleti are good for the stomach; Suilli are dried and hung up, being transfixed with a rush, as in those which come from Bithynia. These are good as a remedy in fluxes from the bowels, which are called *rheumatismi*, and for fleshy excrescences of the anus, which they diminish and in time remove; they remove freckles (lentiginem) and blemishes on women's faces; a healing lotion is also made of them, as of lead, for sore eyes; soaked in water

(68) Pliny, Nat. Hist., XXII., 47.
(69) Paulet, Traité des Champignons, Tome I., 1793, p. 15.
(70) Lenz, *loc. cit.*, p. 760.
(71) W. Houghton, *loc. cit.*, *p.* 32.

they are applied as a salve to foul ulcers and eruptions of the head and to bites inflicted by dogs." Most people have not the slightest conception of the difficulties of pharmacological experiment: they do not appreciate how hard it is, in the absence of strictly comparative observations, to decide whether or not any specific chemical compound administered through the mouth, is really beneficial in any particular kind of illness. If, when taking a certain kind of medicine, they get well, there seems to be a natural tendency to conclude that the medicine has "done them good," notwithstanding the fact that in most cases of illness they would recover if they took no medicine at all. Then, too, the ignorant and the weak love to pin their faith to the dicta of certain men and to certain well-recommended drugs. No doubt by so doing, an optimistic feeling is created which has its curative value; and in some cases, indeed, so-called faith-cures may be effected. Human nature does not alter much even in the course of ages. The factors which induce people at the present day to demand bottles of medicine from their doctors and to purchase quack medicines in such vast quantities, were doubtless at work in the times of the old Greeks and Romans. There is therefore no difficulty in accounting for the belief of the ancients that they could cure the most diverse diseases with *agaricum* and *suilli*, which are now rightly regarded as of little value.

The use of Agaricum has persisted from the time of Dioscorides down to the present day. It is still mentioned in the Pharmacopoeias, but is stated to be unofficial.[72] There seems to be no doubt that, as a powder in larger doses, it acts as a drastic purgative,[73] and that, in smaller doses in the form of *agaricin*, an alcoholic extract, it checks excessive perspiration.[74] Agaricin appears to have the same general pharmacodynamical action as atropine, but to be weaker in its effects.[75] Large doses cause diarrhœa, vomiting, and death through central paralysis.[76] It acts on the sebaceous glands, and hence has been used for inhibiting night-sweats in cases of phthisis.[77] Badham,[78] writing in 1847, tells us of the application of Agaricum for the cure of consumption: "The *Polyporus laricis* [*P. officinalis*], the so-called Agaric of pharmacy, is a powerful but most uncertain medicine, and has also been

(72) T. Sollman, A Text-book of Pharmacology, London, 1906, p. 466; also Potter, Materia Medica, Pharmacy and Therapeutics, ed. IX., Philadelphia, 1903, p. 118.

(73) Potter, *loc. cit.* The drug is called *Agaricus albus, White or Purging Agaric.*

(74) Potter, *loc. cit.*; Sollman, *loc. cit.*, pp. 240 & 466. This author refers to the drug as *Agaricin* from *Boletus laricis.*

(75) (76) & (77) Sollman, *loc. cit.*, p. 240.

(78) C. D. Badham, A Treatise on the Esculent Funguses of England, London, ed. I., 1847; ed. II., 1863, p. 26.

recommended for consumption. I once administered a few grains of it in this disease, when violent pains and hypercatharsis supervened, which lasted for several hours. MM. B. Lagrange and Braconnot found it to contain a large quantity of an acrid resin, to which it no doubt owes its hypercathartic properties. To judge from this single case, which, however, tallies with the experience of others, I should say that the fungus was, in medicine, to be looked upon as a very suspicious ally." These references to modern writers show us that the old Agaricum is endowed with positive pharmacodynamical properties, and that in consequence the belief of the ancients in it was based to some extent on definite experience and not mere fancy. However, that Dioscorides grossly exaggerated the medicinal value of the drug there can be no doubt whatever. No one would now use it for epilepsy, the bites and wounds of serpents, or generally for all internal complaints. The small amount of use to which Agaricum or its extract is put at the present day appears to be due to the fact that for cases in which it is effective, other drugs which act more powerfully, such as belladonna and camphor, have been substituted.[79]

(79) In more recent times, several kinds of fungi, in addition to the Agaricum, have been employed in medicine. The use of Ergot of Rye *(Claviceps purpurea)* in childbirth dates from the middle of the sixteenth century (Frank, Krankheiten der Pflanzen, ed. II., vol. II., Breslau, 1896, p. 468). The ancients, apparently, did not know of its value. It was believed by the Herbalists (e.g., Gerarde, Herball, London, 1636, p. 1584) that the Jew's Ear Fungus *(Hirneola Auricula-Judae)* was a remedy for sore throats. The so-called *Fungi cervini (=Elaphomyces granulatus)* used to be regarded (*vide* Cordus, Annotationes, 1540, published 1561; also J. Bauhin's Historia, 1651, lib. XL.) as aphrodisiacs, and love-potions were made from them. Badham, who was a medical man and evidently very proud of his profession, tells us (Esculent Funguses of England, 1847, ed. II., 1863, p. 25) of the supposed value of *Trametes suaveolens* Fr. in the cure of consumption. He says: "Another fungus, formerly much in fashion, though now put on the shelf, seems really to deserve further trial; I mean *Polyporus suaveolens* (Linn.), which in that most intractable disease, tubercular consumption, surely claims to be tried when there are such respectable authorities to vouch for its surprising effects, in cases where everything else had been notoriously unsuccessful. Sartorius was the first to prescribe it as a remedy in phthisis, and its employment with this view, since his day, has at various times been praeconized on the Continent; the dose being a scruple of the powder two or three times a day." He then cites the case of a young man who had the symptoms of consumption and was supposed to have been cured by treatment with the fungus: "A teaspoonful of an electuary of the *P. suaveolens* was given him three times a day, and *nothing else;* and extraordinary as it may appear, under this treatment the sweats speedily began to diminish with the cough, and after a three months' continuance of the medicine the patient entirely recovered." This belief of Badham and others in *Trametes suaveolens* is very similar to that of Dioscorides in the *Agaricum*. The new sciences of Bacteriology and Pharmacology have had an enormous effect on the treatment of disease. Drugging with fungi for consumption, etc., has now become unthinkable.

ORIGIN OF POISONS IN FUNGI.

So far as the origin of fungus poisons is concerned, Nicander, in a passage already quoted, was the first to express an opinion which has come down to us. He ascribed the poisons to the breath of venomous serpents. Dioscorides[80] held similar views, for he says: "Fungi have a two-fold difference, for they are either good for food or poisonous; their poisonous nature depends on various causes, for such fungi grow either amongst rusty nails or rotten rags, or near serpents' holes, or on trees producing noxious fruits." Pliny,[81] following the Greek writers, says: "Noxious kinds must be entirely condemned; for if there be near them a hob-nail (caligaris clavus), or a bit of rusty iron, or a piece of rotten cloth, forthwith the plant, as it grows, elaborates the foreign juice and flavour into poison; who could discern the different kinds, except country-folk and those who gather them? Moreover they imbibe other noxious qualities besides; if, for instance, the hole of a venomous serpent be near, and the serpent breathe upon them as they open, from their natural affinity with poisonous substances, they are readily disposed to imbibe such poison. Therefore it will be well to exercise care in gathering them until the serpents retire into their holes." Of course, we now know that the poisons of fungi, *e.g.*, phalline, muscarine, etc., are not absorbed directly from without, nor are they manufactured from specific juices taken in from exterior substances, but they arise within the fruit-bodies owing to the metabolic activity of the protoplasm in the hyphae. To discover this, however, was not a simple matter, and it is, therefore, not surprising that the old Greek folk-lore about the nails and serpents' holes, etc., should have persisted for ages. Even some of the Herbalists repeat it without comment, and Matthiolus (1560) goes so far as to add two serpents in his general illustration of fungi.[82]

TESTS FOR DISTINGUISHING BETWEEN EDIBLE AND POISONOUS FUNGI.

The belief that there are one or more simple tests for distinguishing between edible and poisonous fungi, as all mycologists know, is widely held at the present day. However, its extreme antiquity is shown by the fact that Diphilus, a physician who lived about the beginning of the third century B.C. and who wrote a book on *Diets Suitable for Persons in Good and Bad Health*, says: "The wholesome kinds appear

(80) Dioscorides, Mat. Med., IV., 83.
(81) Pliny, Nat. Hist. XXII., 47.
(82) Matthiolus, Commentarii in libros sex Pedacii Dioscoridis Anazarbei de medica materia. Several editions. The illustration of fungi with the two serpents in the edition 1560 is reproduced by Agnes Arber in Herbals, their Origin and Evolution, Cambridge, 1912, p. 185.

to be those which are easily peeled, are smooth and readily broken, such as grow on elms and pines; the unwholesome kinds are black, livid, and hard, and such as remain hard after boiling; such when eaten produce deadly effects."[83] Dioscorides[84] says that poisonous fungi "have a thick coating of mucus, and when laid by after being gathered, quickly become putrid, but others not of this kind impart a sweet taste to sauces." Pliny[85] says: "Some persons have discriminated the kinds of fungi from the kinds of trees on which they grow, such as those found on the fig, the fennel (ferula), and gummiferous trees. We have already spoken of those which are produced on the beech, the oak, or the cypress. . . . All the poisonous fungi have a livid colour," and further, "Those kinds which remain hard after cooking are injurious, while those which admit of being thoroughly well cooked, when eaten with saltpetre are harmless." Horace,[86] in a line often quoted by the Herbalists, says: "Fungi which grow in meadows are the best; it is not well to trust others." It is hardly necessary to state that these tests, of which that of the peeling skin is believed in by many even at the present day, have no true basis in fact: they are not generally applicable and upon them, therefore, no reliance can be placed. The only way to discriminate between fungi which are edible and those which are poisonous is to learn the characteristics of the individual species.

Pliny, in addition to giving general rules for distinguishing poisonous and edible fungi, did indeed refer to certain species as being safe. These were: (1) the *boletus*, which, as we shall shortly see from his description, was undoubtedly *Amanita caesarea*, (2) the fungus which has "a red skin but of a darker hue than occurs in boleti" which Lenz [87] has conjectured to be *Russula alutacea* and Comes[88] *Lactarius deliciosus*, (3) the fungus which is "white, whose stalk closely resembles the apex of a Flamen's cap," which Houghton[89] believes to be *Coprinus comatus*, and (4) the *suilli*, which Paulet and others have identified (I think correctly) with *Boletus edulis*.

REMEDIES FOR EATING POISONOUS FUNGI.

As a remedy for the effects of eating poisonous fungi, the Greeks and Romans rightly recommended an emetic. Already Nicander's complicated mixture has been cited.[90] Among his

(83) Quoted in Athenaeus, Deipnosoph., II., 61, d.
(84) Dioscorides, Mat. Med., IV., 83.
(85) Pliny, Nat. Hist., XXII., 47.
(86) Horace, Sat. II., 4, 20.
(87) Lenz, *loc. cit.*, p. 760.
(88) Comes, *loc. cit.*
(89) Houghton, *loc. cit.*, p. 32.
(90) Nicander, *Vide supra* "The Origin of Fungi," p. 33.

ingredients were vinegar and the dung of the domestic fowl, a curious antidote which long remained in vogue. Some 300 years after the time of Nicander, we find Galen, the celebrated physician of Pergamus (born A.D. 130) saying: "I have heard of a physician of Mysia who administered fowl's dung to persons suffering from fungus poisoning, and I myself have often experimented with the remedy. I have used finely powdered dung mixed with water or with honey and vinegar. The patients immediately on drinking the mixture vomited and recovered. One must observe that the dung of a fowl at liberty is more efficacious than that of one in confinement."[91] Dioscorides appears to have been suspicious of all fungi, for he went so far as to recommend that an emetic should be taken after eating even apparently wholesome kinds. One of the alternatives offered is bird's dung and vinegar. Writing of edible fungi he[92] says: "Even these, if partaken of too freely, are injurious, being indigestible, causing stricture and cholera. As a safeguard, all should be eaten with a draught of olive oil and soda or lye-ashes, with a decoction of salt and vinegar or savory, with marjoram, or they should be followed with a draught composed of birds' dung and vinegar, or with a linctus of much honey; for even the edible sorts are difficult of digestion and generally pass whole with the excrement."

In the Geoponica,[93] a compilation of which neither the author nor the exact date is known, but which may have been produced about 900 A.D., it is said that if any one has eaten a poisonous boletus, he should take as a remedy the juice of the cabbage. In another place myrtle berries are recommended as an excellent remedy against poisonous fungi. Nicander, as we have seen, advised the addition of "the many-coated cabbage" to his emetic, so that the use of the cabbage in cases of fungus poisoning may have lasted for a thousand years. Instead of cabbage, Celsus,[94] who lived about the time of Augustus and Tiberius, prescribed radishes, for he says: "If anyone shall have eaten of noxious fungi, let him eat radishes with vinegar and water (posca) or with salt and vinegar."

That the ancient physicians, like those of the present day, were occasionally called in to attend patients suffering from the effects of eating unwholesome fungi, is shown by the words of Galen, already quoted, in which he says that he had often used the emetic containing fowl's dung. In dealing with a

(91) Galen, De Simplicium Medicamentorum Temperamentis et Facultatibus, IV., p. 303, ed. Kühn.

(92) Dioscorides, Mat. Med., IV., 83.

(93) Geoponica, Translated into German by D. M. Herren and called *Der Feldbaw oder das Buch von der Feldarbeyt,* Strassburg, 1551, p. 156, (lib. XII.).

(94) Celsus, De Med., V., 27, 17.

special instance of poisoning, he[95] says: "I myself know the case of a man who ate a quantity of these insufficiently cooked boleti, supposed to be wholesome, and was afterwards troubled with severe pains in the stomach, with difficulty in breathing, faintness, and cold sweats, and who was with difficulty saved by taking such remedies as are able to dissipate inspissated juices, such as vinegar and honey, either alone or boiled for a time with hyssop and marjoram; the man partook of this remedy sprinkled with soda, and vomited up the fungi which he had eaten."

ATTEMPTS TO NEUTRALIZE THE POISONS OF FUNGI.

The ancients appear to have believed that the poisons of fungi might be neutralized by special modes of preparing the fungi before they were eaten. Thus Celsus[96] says that noxious fungi "can be rendered serviceable by a mode of cooking them; for if they have been boiled in oil or with the young twig of a pear-tree, they become free from any bad quality"; and Pliny[97] remarks that fungi "are rendered more safe still if they are cooked with meat or with pear stalks; indeed, it is good to eat pears immediately after fungi. Vinegar being of a nature contrary to them neutralizes their dangerous qualities." The Romans and Greeks were on the right track in this matter, for we now know that there are means of preparing even the most deadly fungi so that they may be eaten with impunity. The toxic substances in fungi are soluble. Paulet,[98] in his *Traité des Champignons*, published in 1793, pointed out that if poisonous fungi are cut up into pieces and steeped in water containing either salt, vinegar, or alcohol, the poison passes out of them, and they are rendered harmless to animals which are fed on them. It was left, however, to another Frenchman, Frédéric Gérard to give a conclusive demonstration that even such death-dealing fungi as *Amanita phalloides* and *A. muscaria*, if suitably prepared, can be eaten by human beings without any ill effects. Gérard,[99] in a memoir which he sent to the

(95) Galen, De Aliment. Facult., lib. II., cap. 69.
(96) Celsus, De Med., V., 27, 17, *sec.* Houghton, *loc. cit.* p. 26.
(97) Pliny, Nat. Hist. XXII., 47.
(98) Paulet, Traité des Champignons, Paris, 1793, Tom. 2, p. 25.
(99) Gérard published an account of his experiments in Quesneville's *Revue scientifique* in 1850 and 1851. His memoir was republished in Quesneville's *Moniteur scientifique* in 1861, and again by Figuier in his *Année scientifique* (6. année). I have not been able to gain access to any of these publications. However, Figuier has given an excellent account of Gérard's experiments and the report of the commission in his *Histoire des Plantes*, ed. III., Paris, 1880, and it is from this source that my facts are taken. Patouillard in his *Des Champignons au point de vue de leurs Charactères Usuels, Chemiques, et Toxicologiques*, Paris, 1866, also quotes Gérard and states that he has successfully repeated the experiments with poisonous fungi upon animals.

Conseil de Salubrité of Paris in 1851, asserted that he and his family had eaten all kinds of poisonous fungi unscathed. The *Conseil* appointed a commission of three to test this assertion. In the presence of this commission, Gérard prepared and ate on one day 500 grams (1lb. 1·5oz.) of *Amanita muscaria*, and on another 70 grams of *Amanita phalloides*, without the slightest signs of poisoning. The method of preparing the repast was as follows. The poisonous fruit-bodies were cut up into several large pieces, which were washed and left to soak for two hours in a litre (1·75 pints) of water, to which had been added two spoonfuls of vinegar. At the end of this time, the pieces of fungi were taken out of the water, washed under the tap, and then placed in fresh water, where they were boiled for half-an-hour. After this they were washed for a last time in cold water and then wiped dry. Finally they were got ready for the table in the ordinary manner and eaten. The commissioners, two of whom ventured to taste small pieces of the fungi, were quite satisfied with the results of the experiments, and they reported the success which had attended them to the *Conseil*. In giving an account of his researches, Gérard stated that he and his family had eaten more than 75 kilograms of poisonous fungi within a month.[100] Since Gérard's demonstration before the commission at Paris, all doubt as to the possibility of safely eating poisonous fungi has been removed.

Gérard showed that dangerous fungi can be rendered safe even without the use of salt or vinegar by treating them with water alone. In this case, the fungi are first soaked in cold water for two hours, during which time the water is changed twice or thrice; they are then washed and placed in cold water, which is gradually raised to the boiling point; they are then boiled for half-an-hour, after which they are again washed in cold water. As soon as this has been accomplished, they are ready for special preparation as a table-dish, for the poisonous substances have been carried away in the water which has been used for soaking, boiling, and washing.

According to Henri Fabre, the "Homer of the Insect," the

(100) Gérard's instructions for preparing poisonous fungi were as follows: "For every 500 grams of fungi cut up into pieces of medium size a litre of water is required which has been acidulated with two or three spoonfuls of vinegar, or to which two spoonfuls of salt (sel gris) has been added, if one has not got anything else. If one has water only at one's disposal, it is necessary to renew it two or three times. One allows the fungi *to soak for two complete hours*. Then one washes them in plenty of water. They are then put into cold water, which is raised to the boiling point. After half an hour, one takes them out, washes them again, one wipes them, and one prepares them as a special dish. Needless to say that all the water which has been used to wash the fungi, must be thrown away." Figuier, *loc. cit.* p. 297.

peasants of Sérignan, in the South of France, regularly eat many poisonous and doubtful species of fungi, among which he names *Boletus Satanas* Lenz, *B. purpureus* Fr., *Amanita pantherina* DC., *A. citrina* Schaeff., and *Armillaria mellea* Fr. Fabre himself often also indulged in this suspicious food. And yet he says: "During the thirty and more years that I have lived at Sérignan, I have never heard of one case of mushroom-poisoning, even the mildest, in the village." He explains this absence of accident as follows: "In my village and for a long way around, the rule is to blanch the mushrooms, that is to say, to bring them to the boil in water with a little salt in it. A few rinsings in cold water conclude the treatment. They are then prepared in whatever manner one pleases."[101] It is stated in various works that the people of Russia, Poland, and Hungary prepare all kinds of fungi for the table in a similar manner.[102]

We can now return to Celsus and Pliny. In the light of the facts just brought forward, it seems to be a fair conclusion that Celsus was referring to a practice essentially similar to that now employed by the peasants of Sérignan when he stated that noxious fungi "can be rendered serviceable by a mode of cooking them; for if they have been boiled in oil or with the young twig of a pear-tree, they become free from any bad quality." Pliny simply states that "vinegar being of a nature contrary to fungi neutralizes their dangerous qualities." In view of the demonstrations of Gérard, it seems sufficiently probable that in this sentence the great naturalist was referring to the soaking of doubtful fungi in acidulated water as a stage in their preparations for the table. The secret of rendering dangerous fungi harmless may have been known among the ancients only to groups of peasants in various localities. That it was not known universally appears to be shown by the numerous references in classical literature to cases of fungus-poisoning.

(101) J. Henri Fabre, The Life of the Fly, English translation by A. T. de Mattos, Toronto, 1913, pp. 415-425. In his pithy way, Fabre says: "When it leaves the purgatory of the stewpan, the doubtful mushroom can be eaten without fear" (p. 424). He thus comments on the results of boiling fungi: "But this you will tell me, is a system of cookery fit for savages: the treatment with boiling water will reduce the mushrooms to a mash; it will take away all their flavour and all their succulence. That is a complete mistake. . . . Prolonged boiling . . . left them very nearly intact. . . . In the second place there is no loss of succulence and hardly any of flavour. Moreover they become much more digestible, which is a most important condition in a dish generally so heavy for the stomach. For this reason, it is the custom, in my family, to treat them one and all with boiling water, including even the glorious imperial (*Amanita caesarea* Fr.)."

(102) E. Boudier, Des Champignons au point de vue de leurs Charactères Usuels, Chimiques, et Toxicologiques, Paris, 1866, p. 94.

THE BOLETUS OF THE ROMANS.

Pliny, in his Natural History, discoursed at some length on fungi. He was the first to give so good an account of a species of the Boletus of the Romans that we are enabled to identify the fungus with some certainty. Doubtless he was thinking of the species of Amanita whilst writing the passage about to be quoted. His poisonous kinds may have been *Amanita muscaria*, *A. pantherina*, etc., but his description of the edible kind fits *A. caesarea*, a conclusion accepted by Lenz,[103] Badham,[104] and Houghton,[105] and which is supported by tradition. Pliny writes: "Among those things which are rashly eaten I shall rightly place *boleti*, excellent food no doubt, but which have been brought into reproach by an unparalleled instance; for by their means, poison was administered to the Emperor Tiberius Claudius by his wife Agrippina, by which deed she inflicted another poison on the world, and especially on herself, in the person of her own son Nero. Some of the poisonous kinds are known by a dilute red colour (diluto rubore), a loathsome aspect, and internally by a livid hue; they have gaping cracks (rimosa stria) and a pale lip round the margin. But these characteristics are not seen in certain kinds which are dry and like nitre, and which bear on their heads, as it were, white spots formed from their own coating; for the earth first produces a wrapper (volva) and afterwards the fungus itself within the volva, like the yolk in an egg; the young boletus with its volva is very good for food. As the boletus grows, the volva is burst; by and by its substance is borne on the stem; there are seldom two heads on one stem. Their origin is from mud and the acrid juices of moist earth, or frequently from those of acorn-bearing trees; at first it appears as a kind of tenacious foam (spuma lentior), then as a membranous body; afterwards the young boletus appears. . . . The whole existence of a boletus from birth to death is not more than seven days."[106] From this description, it seems clear that the *boletus* of the Romans was an Amanita, namely, *A. caesarea*, and that therefore it was a gilled fungus and quite different from the Boletus of modern mycology, which is provided with hymenial tubes. *Amanita caesarea* does not occur in England but is common in Italy. Bicknell[107] says that it is offered for sale in the markets of Milan, Bergamo, Brescia, Verona, Cremona, Bologna, and other Lombard cities, from the middle of September to the middle of October, and that it is everywhere called *uovolo*.

(103) Lenz, *loc. cit.*, p. 759.
(104) Badham, *loc. cit.*, p. 2.
(105) Houghton, *loc. cit.*, p. 30.
(106) Pliny, Nat. Hist., XXII., 46.
(107) A. S. Bicknell, Notes on the Edible Fungi of Italy, Woolhope Club Transactions, 1884, p. 249.

According to Lenz,[108] the modern Italian names of the fungus are *uovolo*, *uovolo ordinatio*, *uovolo commune*, and *uovolo rancio* (orange-coloured). The name *uovolo* fits in with Pliny's words "like the yoke in an egg," and is very appropriate, as may be seen from the coloured illustrations of the young fruit-bodies when they are bursting through the volva, published by Krombholz,[109] Harzer,[110] and Richon and Roze.[111] Lenz[112] also says that at Verona the fungus is called *fongo ovo*, *fongo bolado*, and *bolè*, and remarks that in the two latter names the ancient name *boletus* still survives.

Paulet, in 1793, stated that in several cantons of Languedoc, where a number of Latin words had survived almost unchanged, *Amanita caesarea* (l'oronge) was called *un bolet*,[113] and further, that, in some parts of France where the Romans had established themselves, this fungus was still known by the name of *boulés*, which is evidently a survival from the Latin *boletus*.[114]

THE CULTIVATION OF FUNGI.

The Mushroom *(Psalliota campestris)* was doubtless known to the Romans, and was probably included by Horace[115] under the name of Meadow Mushrooms, which he said were the best. However, there is no reason to suppose that the Romans cultivated the Mushroom, for, if they had, such writers as Pliny would certainly have referred to the practice. The cultivation of Mushrooms from spawn probably did not take place before the beginning of the seventeenth century. My investigations seem to show that the art first arose in France, probably in the neighbourhood of Paris. The first scientific description of it was given by Tournefort[116] in 1707.

The Greeks and Romans appear to have known a method of growing the Poplar Fungus or *Pholiota aegerita*, a species which is much more common in Italy than in France or England.[117] The accounts of the practice which have come down to us seem rather imperfect, and are evidently given at second hand. Dioscorides[118] says: "Some people say that the bark of the white and black poplar cut into small pieces and scat-

(108) Lenz, Botanik der alten Griechen und Römer, Gotha, 1859, p. 753.
(109) Krombholz, Schwämme, Prag, 1831, Taf. 8.
(110) Harzer, Pilze, Dresden, 1842-45, Taf. 80.
(111) Richon et Roze, Atlas des Champignons, Paris, 1888, Pl. 2.
(112) Lenz, *loc. cit.*, p. 753.
(113) Paulet, Traité des Champignons, Paris, Tome I., 1793, Introduction, p. XIII.
(114) *Ibid.* Part I., p. 13.
(115) Horace, Sat. II., 4, 20 and 21. *Pratensibus* optima *fungis* Natura est; aliis male creditur.
(116) Tournefort, Observations sur la Naissance et sur la Culture des Champignons, Mém. l' Acad. Sci. de Paris, 1707, pp. 58-66.
(117) Richon et Roze, Atlas des Champignons, Paris, 1888, p. 65.
(118) Dioscorides, Mat. Med., I., 109.

tered over dunged spaces will produce edible fungi at all seasons." In the *Geoponica*, a late work, already referred to as having been published possibly about the year 900 A.D., and which contains precepts concerning rural economy, we read: "In order to make fungi grow, one must saw off the stump of a black poplar and pour sour dough dissolved in water upon the cut pieces. Black-poplar fungi soon appear."[119] It seems doubtful whether or not the dough would assist in the infection of the wood unless by keeping its exposed surface moist and thus providing a suitable condition for the germination of the spores.

Another recipe for obtaining fungi is also given in the *Geoponica*, and is as follows:—"If you would have fungi to grow from the ground, you must select a spot of light soil on a hill where reeds grow; there you must collect together twigs and other inflammable materials, and set all on fire just before rain is expected; if the rain does not come, you must artificially sprinkle the spot with pure water; but the fungi thus produced are of inferior quality."[120] Every field mycologist knows that certain species of Hymenomycetes, e.g., *Flammula carbonaria*, etc., come up freely on charred spots in woods where fires have been made. Doubtless this fact had been observed by those who sought to raise fungi artificially by burning wood.

FIRE MADE WITH FUNGUS TINDER.

Pliny tells of obtaining fire with the help of dried fungi. He says: "One piece of wood is rubbed against another, and the friction sets them on fire, which is augmented by dry tinder (aridi fomitis), especially by that of fungi and leaves."[121] Doubtless Pliny had in mind tinder like that known commercially as *amadou*, which is made from fruit-bodies of *Fomes fomentarius* and other Polyporei growing on trees in Europe. I find by enquiry that in the East of Canada, about fifty years ago, before the introduction of matches, it was quite usual in country places to make fire with the help of *punkwood*, i.e., very rotten wood rich in the brown mycelium of a fungus which appears to have been *Fomes fomentarius*. I myself have learned the art of making fire in this way. One takes a piece of flint and holds just below one of its sharp edges a small piece of the punkwood. Then one strikes the edge of the flint smartly with a pocket-knife or a small steel file. Sparks are made and soon one falls upon the punkwood, which immediately begins to smoulder. One then judiciously blows on the

(119) Geoponica, *loc. cit.* XII., 31. The translations of this and the next passage quoted were made by Houghton, *loc. cit.*, p. 41

(120) *Ibid.*

(121) Pliny, Nat. Hist., XVI., 77.

punkwood, and places around it some pieces of the shreddy bark of the White Cedar *(Thuja occidentalis* L.*)*. In a few seconds a flame is produced. I have been told by one who regularly used punkwood that he always carried a piece of it with him in a pouch, as it was an admirable means of lighting his pipe. Thus the use of fungi for tinder, instead of rags, by civilised people, has persisted almost to the present day.[122]

The use of amadou for making fire not improbably originated in prehistoric times. The first historical references to the substance appear to be those of Hippocrates in the fifth century B.C. Hippocrates, writing on the practice of medicine, advised cauterization with a fungus for the cure of certain complaints. Thus he says: "One should cauterize the osseous and nervous parts with fungi *(μύκησι)*"; "Quickly cauterize in eight places so as to intercept the extremities of the spleen"; and "When the liver has attained its greatest volume, one should cauterize with fungi."[123] We are left to suppose, in the absence of more precise details, that the cauterization was accomplished by lighting the tinder and applying it, as it smouldered, to the skin on the outside of the affected organ. Possibly it was thought that the blisters so arising would act as a counter-irritant. Such a treatment was probably entirely ineffective. Its drastic nature finds parallels in the cupping, bleeding, and the searing of wounds with a hot iron, to which patients in a bygone age were forced to submit, and which, owing to the progress of medical science, now happily occupy but a very limited sphere in practical therapeutics.[124]

STONE FUNGI.

According to Athenaeus (A.D. 230), Theophrastus, in his Treatise on Plants, says: "In the sea around the Pillars of Hercules, where there is much water, fungi are produced close to the sea, which people say have been turned into stone by the sun."[125] Doubtless the supposed fungi were certain simple corals which from their radiating calcareous plates remind one of the underside of gilled Hymenomycetes. Some of these

(122) The pouch was made of deer-skin leather and was used to prevent the punkwood becoming moist.

(123) For these quotations which I have not yet seen in the original, *vide* Richon et Roze, Atlas des Champignons, Paris, 1888, Part I., p. 3.

(124) Amadou, in the form of thin, brown, very soft sheets, still has one use in medicine: it is employed by some dentists as an absorbent for drying the teeth. In the preparation of amadou, the flesh of the fruit-bodies of *Fomes fomentarius* is cut into slices, dried, and then beaten until it becomes soft. Amadou was sometimes made into caps, chest protectors, and other articles. Dipped into nitre (KNO_3), its inflammability was increased and it was thereby rendered fit for use as tinder (German tinder), in place of charred rags, for making fire with flint and steel before matches came into general use.

(125) Athenaeus, Deipnosoph. II., 61, f.

corals, from their size and appearance, are so reminiscent of Agaricineae that Lamarck called one of the genera *Fungia*. These stony Mushrooms of the sea were introduced into their works by the Herbalists. Thus John Bauhin, in his famous *Historia Plantarum Universalis* of 1650, described and figured them under the heading *Fungi Lapidei*. He says "Fungi arise in the sea just as on the land, but they are not soft, but stony."[126] The true nature of corals long remained unknown, and the mistaken notions of the ancients and of the Herbalists were not corrected until the middle of the eighteenth century, when Peyssonal, a native of Marseilles, observed the living polypes behave as animals, in that, seated upon their skeletal supports, they opened and closed their mouths and extended and withdrew their tentacles.[127]

THE FUNGI KNOWN TO THE ANCIENTS.[128]

Lenz, Roze, Houghton, and others, have discussed the identity of the fungi mentioned by the Greeks and Romans with our modern species. Among the chief conclusions are the following: the *agaricum* corresponds to our *Polyporus officinalis;* the *boletus* to *Amanita caesarea;* the *suillus* to *Boletus edulis;* the ἀμανῖται to the Common Mushroom *(Psalliota campestris);* the *fungi populi* to *Pholiota aegerita;* the *spongioli* to *Morchella esculenta;* the *pezicae* to Puffballs *(Lycoperdon);* and *tubera* to Truffles. Pliny's second best kind of edible fungus, *fungi candidi, velut apice Flaminis insignibus pediculis*, the white fungi whose stalks closely resemble the apex of a Flamen's cap, may have been our *Coprinus comatus*. Other fungi were mentioned as being associated with particular herbs or trees: that connected with the Ferula (Giant Fennel) was *Pleurotus nebrodensis*, and that found upon the Olive may have been *Pleurotus olearius*. Several different kinds of Truffles were known, among which were doubtless *Tuber brumale, Tuber rufum, Tuber Magnatum*, and *Terfezia Leonis*. The Latin word *fungus* was used to denote any kind of fungus. Similarly, the word μύκης (a slimy, sticky thing), from which we derive the first half of our word *mycology*, was the Greek name for fungi in general. In the following list the various identifications which have been made are set out more fully.

(126) J. Bauhin, Historia Plantarum Universalis, 1650, T. 3, p. 801. The *Fungi Lapidei* had previously been mentioned in their works by Caesalpino in 1583 and Colonna (also known as Fabius Columna) in 1606.

(127) Peyssonal, *sec.* L. C. Miall, The Early Naturalists, their Lives and Works, London, 1912, p. 2.

(128) Only the first paragraph of this section was read during the delivery of the Address.

Amanita caesarea Fr.	=	*Boletus* of Pliny and of all the Latin authors. *Βωλίτης* of Galen.
Amanita muscaria Fr.	=	*Boleti veneni, diluto rubore, rancido aspectu, livido intus colore, rimosa stria, pallido per ambitum labro* of Pliny.
Amanita pantherina Fr.	=	*Boleti sicci, nitri similes, veluti guttas in vertice albas ex tunica sua* of Pliny.
Boletus edulis Fr.	=	*Fungi suilli* of Pliny and Martial. *Fungi farnei* of Apicius (?).
Coprinus comatus Fr.	=	*Fungi candidi, velut apice Flaminis insignibus pediculis* of Pliny.
Fomes fomentarius Fr.	=	*Μύκης* of Hippocrates, used for cauterization. *Aridus fomes fungorum* of Pliny.
Lactarius deliciosus Fr.	=	*Fungi tutissimi, qui rubent callo, minus diluto rubore quam boleti* of Pliny.
Lycoperdon Bovista Linn.	=	*Πέζις* of Theophrastus. *Pezicae* of Pliny.
Morchella esculenta Pers.	=	*Spongiae in humore pratorum nascentes* of Pliny. *Sfonduli, Funguli,* or *Spongioli* of Apicius.
Pholiota aegerita Fr.	=	*Fungi populi* of Pliny. Poplar fungi of Dioscorides. *Μύκητες αἰγειρῖται* of the Geoponica.
Pleurotus nebrodensis Fr.	=	*Fungus ferulae* of Pliny.
Pleurotus olearius Fr.	=	Fungi of the Olive of Athenaeus.
Polyporus officinalis Fr.	=	*Agaricum* of Pliny. *Ἀγαρικόν* of Dioscorides.
Psalliota campestris Fr.	=	*Fungi pratenses* of Horace. *Fungi albi* of Ovid. *Ἀμανῖται* of Galen.
Puccinia graminis Pers., etc.	=	*Robigo veris* of Pliny, Ovid, etc.
Terfezia Leonis Tul.	=	*Misy* of Pliny and Athenaeus. *Tuber veris* of Juvenal.
Tuber Mich.	=	The general Latin name for Truffle including the *misy* and *ceraunium* of Pliny. *Ὕδνον* of Theophrastus and Greek writers.

Tuber brumale and T. melanospermum Vitt.	=	*Tuber colore nigro* of Pliny.
Tuber Magnatum Pico	=	*Tuber colore intus candido* of Pliny.
Tuber rufum Pico	=	*Tuber colore rufo* of Pliny.

AMANITAE.—In a former section, we have already discussed the identity of the most famous of all the fungi known to the ancients, the *Boletus*, with *Amanita caesarea*. It was shown that it rests chiefly on Pliny's description of the fungus, especially on that part of it where he describes the young fruit-body in one stage of its development as being "like the yolk in an egg"; but that it also rests upon the partial survival of the original name through tradition.[129] We are on less sure ground with *Amanita muscaria* and *Amanita pantherina*. Here again we have to rely on Pliny's descriptions. The former species may have been in Pliny's mind when he spoke of "poisonous kinds" of Boleti, "known by a dilute red colour, a loathsome aspect, and internally by a livid hue" which have "gaping cracks and a pale lip round the margin"; and the latter species may have been included in his "certain kinds" of Boleti "which are dry and like nitre, and which bear on their heads, as it were, white spots formed from their own coating."[130] It may be added that the word *boletus* is supposed to have been derived from the Greek word βῶλος = "a clod," a round mass (= Latin *gleba*), perhaps in allusion to the ball-like form of the young fungus.[131]

BOLETUS EDULIS.—Commentators are generally agreed that the *Fungi suilli* of Pliny and Martial are identical with our *Boletus edulis*. Porta,[132] who lived at Naples, mentions in his *Libri XII. Villae*, published in 1592, an edible fungus which was known locally as *Silli;* and Paulet[133] in 1793 pointed out that in certain parts of France the words *Suillous*, *Siallous*, and *Nissoulous*, had survived as names for our modern species of Boletus. The word *suillus* was derived from *sus*, a pig, and means *something relating to swine*. The Suillus probably obtained its name from the fact that pigs were fond of it. Berkeley[134] states that pigs devour *Boletus edulis* as well as Truffles. The modern Italian name for *Boletus edulis* is

(129) *Vide supra* "The Boletus of the Ancients," p. 45.
(130) *Ibid.* The passage in which these descriptions occur is quoted.
(131) *Cf.* Houghton, *loc. cit.* p. 48.
(132) Porta, Libri XII Villae, cap. LXX., lib. X., reprinted by Clusius in his Brevis Historia Fungorum of 1601, and again by Istvanffi in his work on Clusius in 1900.
(133) Paulet, Traité des Champignones, Paris, Tome I., 1793.
(134) *Sec.* Houghton, *loc. cit.*, p. 32. I cannot find Berkeley's statement.

Porcino,[135] which means *porcine*, and therefore has the same significance as Suillus. That the *Fungi farnei* of Apicius[136] are *Boletus edulis* is merely a matter of conjecture. Pliny,[137] in one passage, speaks of *suilli venenis accommodatissimi*. This is believed by Lenz,[138] Roze,[139] and others, to refer to *Boletus Satanas* and allied poisonous species. On the other hand, the words *venenis accommodatissimi, convenient for poisoning*, have been interpreted by Houghton as being applied to the edible *Boletus edulis*, and he brings forward historical reasons for supposing that Pliny meant to intimate that this harmless fungus had been used as a means of removing Annaeus Serenus by means of a poison introduced into it from without.[140] In this connection it will be remembered that Claudius Cæsar was poisoned through the agency of an edible Boletus *(Amanita caesarea)*.[141] Pliny mentions Suilli, along with Boleti, as being "the most recently discovered stimulants of the appetite (gulae novissima irritamenta)."[142] The fungus was therefore held in high esteem as a delicacy. However, the Suillus was not thought to have as good a flavour as the Boletus *(Amanita caesarea)*, for Martial in an Epigram in which he says: "You reserve Boleti for yourself; I am given Suilli (Sunt tibi boleti: fungos ego sumo suillos)," complains to Ponticus that when invited to dinner, his host had not set before him the choicest dainties.[143] The superiority of the ancient Boletus to the Suillus is borne out by the testimony of Paulet, Roques, Vittadini, and others. The *Amanita caesarea* is described by Roques as the finest and most delicate of fungi, whilst Vittadini speaks of it as the most delicious in Italy.[144]

COPRINUS COMATUS.—Pliny's *Fungi candidi, velut apice Flaminis insignibus pediculis* or White Fungi whose stalks closely resemble the apex of a Flamen's cap, which, he said, were safe to eat, have proved very puzzling to commentators.[145] The apex of a Flamen's cap, as may be seen from ancient representations of it, much resembled the spike of a helmet: it was a conico-cylindrical structure, tapering somewhat from below upwards, three or four inches long, and about an inch in diameter at the base. It was made from an olive

(135) *Vide* G. Negri, Atlante dei Principali Funghi commestibili e velenosi, Torino, 1908, p. 78.
(136) *Vide supra*, footnote (7), p. 22.
(137) Pliny, Nat. Hist. XXII., 47.
(138) Lenz, *loc. cit.* p. 760.
(139) Richon et Roze, *loc. cit.* p. XXVI. Roze mentions *Boletus luridus*, etc.
(140) Houghton, *loc. cit.* p. 31.
(141) *Vide supra*, "Edible and Poisonous Fungi," p. 25.
(142) Pliny, Nat. Hist. XVI., 8 (*sec.* Houghton).
(143) Martial, Ep. III., 60.
(144) *Vide* Richon et Roze, *loc. cit.* p. 7.
(145) Pliny, Nat. Hist. XXII., 23, 47.

twig, which was closely wound round with a band of wool. Where it joined the cap, it passed through a horizontal disc which varied in diameter from about 1·5 to 4 inches.[146] Lenz[147] remarks that Pliny, in describing his *Fungi candidi*, was evidently thinking of a fungus which was provided with a delicate ring. Some writers[148] have suggested that Pliny had in mind branched Clavariae, such as *Clavaria Botrytis* and *C. flava;* but this seems to me very unlikely, as these fungi do not resemble the apices either in form or colour. The best conjecture so far made appears to be that of Houghton,[149] who thinks that Pliny's fungus was *Coprinus comatus*. However, Houghton translates Pliny's description as follows: "white fungi whose head-stems are similar in form to the caps of the Flamens." He thus, it seems to me without any good reason, makes *pediculis* refer not to the stipes but to the pilei (head-stems) of the fungi. Houghton says: "Most of the forms of this cap (apex), as shown on coins and bas-reliefs of the Roman emperors, are of a conical or cylindrical form, and remind one of the cylindrical pileus of the very excellent *Coprinus comatus* before it expands and deliquesces; at least I know of no other edible fungus that so much resembles the figure of these priestly caps." Possibly Pliny had in mind the stipes of *Coprinus comatus*, for these are easily detached from their pilei, white, conico-cylindrical, and encircled by a ring. *Coprinus comatus* is one of the commonest species of edible fungi in Europe, and it doubtless came up in the Roman fields in the days of the Emperors. Badham[150] says that in his time (1847) it was largely eaten about Lucca, and Negri[151] has included it in his recent popular work on the chief edible and poisonous fungi of Italy. The fruit-bodies are usually quite free from maggots and, if cooked before the pilei have expanded, possess an excellent flavour. There is no doubt about the safety of this species: it has never been known to poison anybody.[152]

FOMES FOMENTARIUS.—The view that Pliny's *Fomes fungorum* or fungus tinder was a part of the fruit-body of *Fomes fomentarius* from which the amadou of commerce is made, or very rotten wood heavily laden with its mycelium (touchwood), has

(146) A description and illustrations of the apices and caps of the Flamens are given in the article *Flamen*, Dictionnaire des Antiquités Grecques et Romaines, Paris, now in course of publication.

(147) Lenz, *loc. cit.* p. 760.

(148) *Cf.* Roze, *loc. cit.* p. XIII.

(149) Houghton, *loc. cit.* p. 32.

(150) Badham, The Esculent Funguses of England, ed. II., London, 1863 p. 42.

(151) Negri, *loc. cit.* p. 76.

(152) I know its good qualities from personal experience.

already been discussed.[153] Badham, who lived in Italy for some time, writing in 1847, says: "Amadou is largely used in Italy, where it is called *esca;* the Latins likewise knew it by this name, though their more common appellation for it was *fomes;* the Byzantine Greeks hellinized *esca* into ὕσκα, which was their word for it; the ancient Greeks called it ζώπυρον." He then quotes Salmasius, a French scholar (1588-1653) who wrote a commentary on Pliny: "Salmasius tells us how amadou used to be made in his time, which indeed was the same as now: the fungus was first boiled, then beaten to pieces in a mortar, next hammered out to deprive it of its woody fibres, and lastly, being steeped in a strong solution of nitre, was left to dry in the sun."[154] It is uncertain whether Pliny's fungus tinder was prepared in this way. It is possible that it simply consisted of raw pieces of the flesh of *Fomes fomentarius* or of untreated scraps of touchwood.[155] There is also the possibility that, as a source of tinder, not merely *Fomes fomentarius* but also some other species of Fomes may have been employed.

LACTARIUS DELICIOSUS.—In writing of Fungi as opposed to Boleti, Pliny[156] states that "the safest are those whose skin becomes red but a less dilute red than that of the Boleti." We can only guess what this fungus was, for Pliny has told us nothing more than that it is good to eat and of a red colour. Lenz[157] suggested that the species was either *Russula alutacea* or *Tricholoma Russula*, and he supported the claim of the former by mentioning that, in addition to its being highly regarded as a comestible, it was called (1859) *fungo rossetto* at Verona and *rossola buona di gambo lungo* or *rossola mezzara* in Italy generally. Subsequently Comes examined the Pompeian fresco which shows some fruit-bodies of an Agaric which he identified as *Lactarius deliciosus.* Thereupon he made the suggestion that this species was the red-skinned fungus of Pliny.[158] It is well known that the species of Russula and Lactarius range through many shades of colour and that colour alone is insufficient for their identification. We must therefore consider the problem of the identity of Pliny's safest fungus as unsolved.

LYCOPERDON.—We now come to Lycoperdon. Theophrastus, as we have seen, mentioned a fungus which he called the *Πέζις*,

(153) *Vide supra* "Fire Made with the Help of Dried Fungi," p. 46.
(154) Badham, Esculent Funguses of England, London, ed. I., 1847; ed. II., 1863, p. 22.
(155) Fire can be made with such raw tinder as I have already pointed out, *vide supra* p. 46.
(156) Pliny, Nat. Hist. XXII., 47.
(157) Lenz, *loc. cit.* p. 760.
(158) Comes, *vide supra* "The First Illustration of a Fungus," p. 29.

and stated that it was rootless.[159] Pliny in his Natural History says: "Among fungi there are those called *pezicae* by the Greeks, which grow without root or stalk."[160] There has been a difference of opinion as to the identity of the fungus thus described. Fabius Columna in his *Ekphrasis* of 1606 gave illustrations of two species of Cup-fungi (Discomycetes) and called them *Fungi pezicae* of Pliny. Dillenius,[161] in 1718, altered the name *Pezica* to *Peziza*, and under this form it has survived and is now in use for a well-known genus included in the Ascomycetes. This interpretation was probably erroneous. On general grounds, it may perhaps be urged that it is unlikely that Theophrastus would have mentioned such small and relatively insignificant fungi as our modern Cup-fungi, and that he probably had in mind a fairly large species with some striking characteristic which would make it known to everyone. Lenz[162] and Houghton[163] hold that Pezica was the name given to certain Puff-balls, and with this view the present writer is inclined to concur. Houghton's commentary is as follows: "The Greek forms of *πέζις, ιος* and *πέζιξ, ικος* occur in Theophrastus and Athenaeus. The former says nothing whatever about the *πέζις*, except that it has no root; but Athenaeus quotes Theophrastus as saying that the *πέζις*, together with the *ὕδνον, μύκης*, and *γεράνειον*, has a smooth skin, *λειόφλοια*. Lenz[164] in a footnote writes: 'The *πέζις* of Theo-

(159) *Vide supra* "The Dawn of Mycology," p. 27.
(160) Pliny, Nat. Hist., XIX., 3.
(161) Dillenius, Catalogus Plantarum circa Gissam Sponte nascentium, Francofurti, 1718, p. 194.
(162) Lenz, *loc. cit.* p. 755.
(163) Houghton, *loc. cit.* p. 35.
(164) Lenz, *loc. cit.* p. 755. Lenz mentions *peto* as well as *vescia*.
(164A) The Greek name *πέζις* is derived from *πέζα*, "the foot," "bottom," "base," that which rests on its base, "sessile" (*sec.* Houghton, *loc. cit.* p. 48). The most striking feature about a Puffball to the casual observer is that when a ripe one is pressed with the fingers, it puffs usually from an aperture at the top: a jet of air is expelled containing a cloud of brown dust which is unpleasant for the eyes, nose, and throat. On this account the Puffball, on the continent of Europe, was given a popular but very vulgar name. This was translated by the early commentators on Dioscorides (e.g. Ruelle 1536) into the Latin *Crepitus lupi*. Concerning the nomenclature of the Puffball, Henri Fabri (Life of the Fly, Translation, Toronto, 1913, pp. 397-398) makes the following amusing comments: "Ennobled by Latin which provided me with my first exercises and translations, glorified by the ancient language which the rector used in saying his mass, the mushroom rose in my esteem. To deserve so learned an appellation, it must possess a genuine importance. The same books told me the name of one that had amused me so much with its smoking chimney. It is called the puffball in English, but the French name is the *vesse-de-loup*. I disliked the expression, which to my mind smacked of bad company. Next to it was a more decent denomination: *Lycoperdon;* but this was only so in appearance, for Greek roots sooner or later taught me that *Lycoperdon* means *vesse-de-loup* and nothing else. The history of plants abounds in terms which it is not

phrastus and the *pezica* of Pliny are without doubt the *bovista* (die Boviste).' He compares the modern Italian name *vescia*, both in sound and meaning, with the Greek πέζις. The λειόφλοια of Theophrastus would seem to point to the smooth-skinned *Lycoperdon giganteum (L. Bovista* L.*)*."[164a]

MORCHELLA ESCULENTA.—Pliny says: "And we shall call fleshy things (carnosa) certain other vegetables such as *Sponges* which grow in the wet places of meadows (ut *spongias* in humore pratorum enascentes)," and then he adds that he has spoken of Fungi and Tubera already.[165] Apicius, the writer on Roman cookery, gives recipes for the preparation of four sorts of fungi, of which one is called *Sponduli*, *Funguli* or *Spongioli*.[166] It has been supposed that the *Spongiae* of Pliny and the *Spongioli* of Apicius were names for *Morchella esculenta* and allied species.[167] There can be little doubt that the Spongiolus of Apicius was a common fungus, well known, and held in high repute as a comestible, for, if this had not been so, it is unlikely that Apicius would have given several recipes for its preparation. Such a fungus is *Morchella esculenta* at the present day. Then, too, the ancient name of *Sponge* for a particular kind of fungus has survived. In 1592, as we learn from the Neapolitan Porta,[168] one of the edible fungi coming up in spring in Southern Italy was called *Spongiole* owing to its resemblance to a sponge. At the present day, the Italians call the genus Morchella by the name of *Spugnola* (Spugna = sponge). The *Morchella esculenta*, which like Porta's Spongiole appears in spring,[169] is *Spugnola gialla*. It seems altogether likely that the modern fungi called Sponges and the ancient ones which bore the same name, are identical. Assuming this to be the case, we are justified in supposing that the Spongioli of Apicius and perhaps also the

always desirable to translate. Bequeathed to us by earlier ages less reticent than ours, botany has often retained the brutal frankness of words that set propriety at defiance." The old *Bubenfist* or *Boviste* of the Germans (*Bube* = boy, knave, etc.), which was the name given to the Puffball, doubtless arose in a similar manner to *vesse-de-loup*. The name *Lycoperdon* was invented by Tournefort and published in his *Institutiones Rei Herbariae* in the year 1700.

(165) Pliny, Nat. Hist. XIX., 22. (*Sec.* Richon et Roze, p. XVII.).

(166) Apicius, De Arte Coquinaria. *Vide supra* p. 22, (7).

(167) *Cf.* Roze, *loc. cit.* p. XXVI., for the Spongiae of Pliny; Houghton, *loc. cit.* p. 47, for the Spongioli of Apicius 22, (7).

(168) Porta, Libri XII Villae, 1592, *loc. cit.* The Morchella pileus, with its numerous deep surface cavities, is the part which is reminiscent of certain bath-sponges.

(169) *Vide* G. Negri, Atlante dei Principali Funghi commestiblili e velenosi, Torino, 1908, pp. 92-96. The Helvellae as well as the Morchellae are called in Italy by the name of Spugnola.

Spongiae of Pliny were names applied to *Morchella esculenta* and its allies.[170]

PHOLIOTA AEGERITA.—An edible fungus which grew on Poplar trees, was mentioned by Pliny, by Dioscorides, and in the Geoponica. Pliny says: "There are three kinds of Poplar: the Black Poplar, the White Poplar, and one called the Libyan with very small leaves, which is very dark and very highly valued on account of the fungi which it produces."[171] Dioscorides and the Geoponica tell us how the fungus may be cultivated on pieces of Poplar wood.[172] The fruit-bodies were referred to by Pliny as *Fungi populi*, and in the Geoponica as *μύκητες αἰγειρῖται*. Porta, in 1592, mentions the *Aegeritae* as fungi which can be grown on wood in the manner described by the ancients.[173] What then was the fungus of antiquity which grew on Poplars and was held in such high favour as a table delicacy? In all probability it was *Pholiota aegerita*, a well-flavoured species which grows on Poplar trees in Southern Europe at the present day. Henri Fabre,[174] who lived in the very South of France, describes this species from personal experience as "one of our best mushrooms, despite its colour of a doubtful white, its skin which is often wrinkled, and its gills soiled with rusty brown by the spores." His praise matches that implied in the writings of the Greeks and Romans. The cultivation of the Poplar fungus took place as late as the nineteenth century. Badham,[175] in 1847, tells us that, in the Botanical Gardens of Naples, he saw a row of pollarded heads of Black Poplar trees *(Populus nigra* var. *Neapolitana)*, which were bearing an edible fungus, and stated that it was the custom to keep such heads for years for the purpose of obtaining the fungi which they yielded. Cordier,[176] in 1876, mentions that Deveaux grew an edible fungus on sections of a Poplar trunk which were 3 to 4 cm. thick and had been placed in the soil. Badham called his fungus *Agaricus caudicinus*, and Deveaux his *Agaricus attenuatus* DC. var. *cylindricus* Fr. These may have been mistakes in nomenclature. The general consensus of opinion (Fries,[177]

(170) Pliny does not say that his Spongia is edible. He simply tells us that it is fleshy and grows in wet spots in meadows. It is possible that for him the name Sponge may have had a somewhat different significance to that which it had for Apicius and which it has now. In this connection it should be mentioned that in Germany the fleshy fungi generally are all known by the name of *Schwämme* (Sponges).

(171) Pliny, Nat. Hist. XVI., 35.

(172) *Vide supra* "The Cultivation of Fungi," p. 46.

(173) Porta, Libri XII Villae, lib. X., cap. LXX., Reprinted in Istvanffi's Clusius.

(174) Henri Fabre, *loc. cit.* p. 405 (1913).

(175) Badham, Esculent Funguses of England, ed. I., 1847, ed. II., 1863, p. 50.

(176) F. S. Cordier, Les Champignons de la France, Paris, 1870, p. 99.

(177) Fries, Epicrisis Systematis Mycologici, Upsaliae, 1836-1838, p. 164.

Roze,[178] Houghton,[179] etc.) is that the ancient and modern Poplar fungus is *Pholiota aegerita* Fr.[180]

PLEUROTUS NEBRODENSIS.—Pliny speaks of the fungi associated with certain trees as follows: "Some persons have discriminated the kinds of fungi (edible and poisonous) from the kinds of trees on which they grow, such as those found on the Fig, the Giant Fennel, and gummiferous trees. We have already spoken of those which are produced on the Beech, the Oak, or the Cypress."[181] The Giant Fennel is one of the tallest species in the Umbelliferae and is found in Southern Europe. Pliny's name for it was *Ferula*, which it bears in Southern Italy to this day.[182] Linnaeus called the species *Ferula communis*.[183] In France its common name is *la Férule*. The *Fungus ferula* of Pliny has been identified by Roze as *Pleurotus nebrodensis* Fr. This commentator says: "Another fungus mentioned by Pliny, and concerning which there is no uncertainty, is that of the Giant Fennel *(Pleurotus nebrodensis)*, which is still very much liked in our time in Italy and Algeria."[184] Fries[185] mentions that, at the present day, this species grows on the roots of Umbelliferae in Sicily and under *Ferula communis* in Cyprus.

PLEUROTUS OLEARIUS.—Athenaeus quotes Nicander as saying in his Georgics, a lost work, that the fungi of the Olive, the Pomegranate (?), and the Holm-oak, are vegetable excretions, enemies of the human body, clammy choking lumps which are mortal in their effects.[186] What were the fungi on the Pomegranate and the Holm-oak it is difficult to guess, but that on the Olive is believed by Roze[187] and others to be *Pleurotus olearius* DC. This species grows on Olive trees in Southern Europe at the present day, but not exclusively thereon, for Henri Fabre,[188] who lived in the South of France, says: "Its popular name (the olive-tree agaric) is not very appropriate. True, it frequently grows at the base of old olive-trees, but I also pick it at the foot of the box, the holm-

(178) Roze, *loc. cit.* p. XIV.
(179) Houghton, *loc. cit.* p. 42.
(180) Lenz (*loc. cit.* p. 764) called the Poplar fungus *Agaricus mutabilis*. Probably, like Badham and Deveaux, he erred in his identification.
(181) Pliny, Nat. Hist. XXII., 47.
(182) Lenz, *loc. cit.* p. 563. Houghton (*loc. cit.* p. 31) translated *ferula* as Birch. This is an error. The Birch does not grow in Greece, and in North Italy it is found only on the sides of tall mountains. Pliny called it *betulla* and said that it preferred a cold habitat and was really a Gallic tree (Lenz, *loc. cit.* p. 392).
(183) Linnaeus, Species Plantarum, ed. III., p. 355.
(184) Roze, *loc. cit.* p. XIII.
(185) Fries, Hymenomycetes Europaei, Upsaliae, 1874, p. 171.
(186) Athenaeus, Deipnosoph. II. (*sec.* Roze and Houghton).
(187) Roze, *loc. cit.* p. XXVI.
(188) Henri Fabre, *loc. cit.* p. 418.

oak, the plum-tree, the cypress, the almond-tree, the Guelder rose, and other trees and shrubs. It seems fairly indifferent to the nature of its support." Fabre describes the fungus as "a magnificent mushroom, coloured jujube-red." Its striking appearance must therefore have attracted attention to it in antiquity just as at the present day. Further, it is undoubtedly very poisonous, for, on this point the united observations of Micheli, Cordier, Destrems, Mierge, Planchon, and Réguis, leave no doubt whatsoever.[189] The identification of the Olive fungus of Nicander with *Pleurotus olearius*, therefore, may well be a correct one.

POLYPORUS OFFICINALIS.—The *Agaricum*, as we have already seen, was a fungus which was described by Dioscorides and held by him in high favour on account of its medicinal properties.[190] It was also recommended by later writers such as Galen and Pliny. There can be no doubt that the Agaricum is identical with our *Polyporous officinalis* Fr. (= *Fomes officinalis* = *Fomes Laricis*).[191] Both grow on trees, and both have a peculiar taste and a strong purgative action. Moreover, as we learn from Harduin,[192] in the mountains of the province of Dauphiné, in the East of France, the ancient name of Agaricum for *Polyporus officinalis* has survived by tradition. The fungus has continued in use in medicine from the time of the Greeks and Romans almost to the present day.[193] Dioscorides tells us that the Agaricum grows in Agaria of Sarmatia. It therefore appears that its name was derived from the locality in which it was procured. Sarmatia was part of Russia, so that the Agaricum was brought to Greece and Italy from a considerable distance. Sprengel, commenting on Dioscorides, wonders at this, for he points out that the Romans could easily have obtained the fungus from Rhaetia, Vindelicia, and Noricum, provinces on the Danube, much nearer home than the far-off Agaria. "Still," he remarks, "even in our time (1818) agaricum, which Europeans consider a most excellent kind, is sent from the remote Ural mountains as well as from Syria."[194] Houghton[195] explains the import of the fungus from Sarmatia as follows. The promontory of Agarum was the country of the Agari, a people skilled in medicine and said to have been able to cure wounds with ser-

(189) *Vide* Roze, *loc cit.* p. 153.
(190) *Vide supra* pp. 33, 35, on "The Sexes of Agaricum" and "The Medicinal Properties of Fungi."
(191) For a list of synonyms *vide supra*, footnote (63), p. 34.
(192) Harduin, *sec.* Lenz, *loc. cit.* p. 758.
(193) *Vide supra* "The Medicinal Properties of Fungi," p. 35.
(194) Sprengel, Geschichte der Botanik, Altenburg und Leipzig, Vol. II., 1818, p. 490 (*sec.* Houghton, *loc. cit.* p. 27).
(195) Houghton, *loc. cit.* p. 28.

pent's venom. Some of the Agari attended Mithridates the Great as physicians. Hence a special value would be attached to Agaricum procured from such a renowned district.

The Agaricum is treated of in the all-embracing Natural History of Pliny, and it is included in the materia medica of Galen. Pliny in one passage writes as follows: "The Agaricum grows like a fungus on trees around the Bosphorus: it is of a white colour; it is given in four-obol doses mixed with two cyathi of honey and vinegar. That which grows in Gaul is considered of an inferior kind. The male is thicker and more bitter than the female; it cures headaches; the female, which is of looser texture, is at first sweet to the taste and as it is swallowed it leaves a bitter taste."(196) The white colour is correct for *Polyporus officinalis*. As for the rest of the description, part of it at least may have been taken from Dioscorides. In another passage Pliny says: "The acorn-bearing trees (arbores glandiferae) of the Gallic provinces more particularly produce Agaricum; it is a white fungus with a strong odour, useful as an antidote; it grows on the tops of trees and shines at night; by the help of this light its presence is made known and it is gathered."(197) Here Pliny seems to have been the victim of incorrect information obtained at second hand. It is true that in the East of France, among the mountains, where, as already mentioned, the ancient name has survived, the Agaricum is very common; but it never grows on the Oak, always on the Larch.(198) It is also true that the fungus is white, has a strong odour, and possesses medicinal properties; but the statement that "it grows at the tops of trees and shines at night, by which fact its presence is known and it is gathered," is quite erroneous. There is no evidence that the fruit-bodies of *Polyporus officinalis* emit light. However, there is a tree-fungus which grows in the South of Europe, including Italy, which has long been known to be distinctly phosphorescent, namely, *Pleurotus olearius* DC. The fruit-bodies of this species do indeed shine at night, as Battarra first noticed in 1755. Confirmation of the fact has been given by De Candolle, Delile, and Tulasne.(199) However, the glow, according to Henri Fabre, who observed it in the South of France, "is exceedingly faint, so much so that it is not perceptible except in the deepest darkness."(200) In a preceding paragraph grounds have been given for the belief that

(196) Pliny, Nat. Hist. XXV., 9. The male and female kinds of Agaricum were discussed in a previous section on "The Agaricum."
(197) *Ibid.* XVI., 8.
(198) Chorier, Hist. Delph. I., 1, p. 58 (*sec.* Lenz, *loc. cit.* p. 758).
(199) For a resumé of the history of this subject *cf.* Hans Molisch, Leuchtende Pflanzen, Jena, 1904, p. 30.
(200) Henri Fabre, *loc. cit.* p. 418.

Pleurotus olearius was known to the ancients as the Olive-tree fungus. It is therefore a possibility that Pliny, when stating that the Agaricum shines at night, was in reality, owing to a confusion of species, referring to the remarkable phenomenon of phosphorescence of the fruit-bodies of *Pleurotus olearius*.[201]

PSALLIOTA CAMPESTRIS.—There can be no doubt that the Common Mushroom *(Psalliota campestris)* was known to the ancients, as to-day it is of frequent occurrence in the fields of Italy and Greece, where it is highly esteemed on account of its delicious flavour and its perfect innocuity.[202] Horace[203] probably had it in mind when he said: "Fungi which grow in meadows are the best; it is not well to trust others *(Pratensibus* optima *fungis* Natura est; aliis male creditur)." It seems likely, too, that Ovid[204] was also making a reference to it when he described a frugal peasant woman in her daily work as sweeping out the cottage, setting hens on eggs, and gathering green mallows and white fungi (Aut virides malvas aut *fungos* colligit *albos*). The modern Italian name of the Mushroom is *Prataiuolo*,[205] which at once suggests the *Fungi pratenses* of Horace.

There seem to be good grounds for believing that the Amanita *(Αμανῖται)*, a Greek name first used by Galen,[206] was the usual appellation in ancient Greece for the Common Mushroom. Houghton[207] and Roze[208] are in agreement on this point. The latter says: "Support for this opinion is given by the fact which was determined by Krombholz and has kindly been confirmed for me by M. Gennadius, Inspector of Agriculture in Greece, that in the present Greek language our wild Mushroom, which is gathered in abundance after rain in all pastures, is called by the name of Manitari *(Μανιτάρι)*. To-day, all the edible Mushrooms are called in Greece Manitaria *(Μανιτάρια)*. This word, which is the equivalent of the French word *champignons*, is derived in all probability from the mountain Amanon *(Αμανον)* in Cilicia, whence *Αμανον = Αμανίτα = Μανιτάρι*. Some specimens of fungi which in Greece bear this name more especially, and which, in the most obliging manner, have been sent to me by M. Gennadius,

(201) Fries (Hymenomycetes Europaei, 1874, p. 170) says concerning *Pleurotus olearius:* "Lamellarum *phosphorescentia* maxime insignis et antiquitus celebratus." I presume that in the last phrase he was referring to the passage from Pliny which has just been discussed.
(202) For Italy *vide* G. Negri. Atlante dei Principali Funghi commestibili e velenosi, Torino, 1908, p. 72.
(203) Horace, Sat. II., 4, 20-21.
(204) Ovid, Fast. IV., 697.
(205) Negri, *loc. cit.*
(206) Galen, De Aliment. Facult. lib. II., 69.
(207) Houghton, *loc. cit.* p. 48.
(208) Roze, *loc. cit.* p. XXIII.

allow me to state that the name is certainly applied to our Common Mushroom *(Psalliota campestris)*." This identification of the ancient Amanita with *Psalliota campestris* fits in well with Galen's recommendation[209] that people should not eat any other species of fungi than the Boletus *(Amanita caesarea)* and the Amanita, for we know that the Common Mushroom is perfectly wholesome.[210]

PUCCINIA GRAMINIS, etc.—The *Robigo* or Rust of cereals was mentioned, as we have already seen, by a number of ancient authors, and interesting particulars were given concerning it by Pliny and Ovid.[211] The red spots and streaks which the Romans saw on the leaves and haulms of their Wheat, Rye, Oats, and Barley, must have been the uredospore-pustules of various species of *Puccinia*, e.g., *Puccinia graminis*, *P. dispersa*, *P. glumarum*, *P. coronata*, etc., which commonly occur at the present day in Europe. One kind of Rust fungus which was observed to make its appearance early in the year was called by De Candolle *Puccinia Rubigo-vera*. In 1894, Eriksson and Henning showed that this is a collective species, and they split it up into the Yellow Rust, *Puccinia glumarum*, and the Brown Rust, *Puccinia dispersa*.[212] Hence the specific name *Rubigo-vera*, which was reminiscent of the Robigalia festival of the Romans, has been discarded.

TRUFFLES.—The Greeks and Romans were fond of Truffles and certainly knew several different kinds, as is shown by several passages already quoted from the writings of Pliny, Theophrastus, Plutarch, and Juvenal.[213] Theophrastus was the first to mention these subterranean fungi. He speaks of the *ὕδνον*, which some call *ἄσχιον*, and the *οὔϊγγον*, and other such subterranean things, as having no root.[214] In another passage,[215] he says that the *ὕδνον* is sometimes called *μίσυ*, that it is very sweet with a fleshy odour; and that in Thrace it is called *ἴτυν*. Then he tells of the popular belief that Truffles are produced by thunderstorms, and of certain localities in which they are found. Dioscorides[216] calls the *ὕδνον* a root, and says that it is roundish, without leaves and stem, inclining

(209) Galen, *loc. cit.* Also *vide supra* "Edible and Poisonous Fungi," p. 26.
(210) Another possible reference to *Psalliota campestris* is to be found in the remark of Theophrastus (*circa* 300 B.C.) that the fungi (*μύκητες*) which grow on dung have no bad smell. *Vide supra*, p. 27.
(211) *Vide supra* "The Rust Disease," p. 30.
(212) J. Eriksson and Ernst Henning, Die Hauptresultate einer neuen Untersuchung über die Getreideroste. Zeitschrift für Pflanzenkrankheiten, Bd. IV., 1894, pp. 197 and 257.
(213) *Vide supra*, "The Origin of Fungi," p. 31.
(214) Theophrastus, Hist. Plant. I., 6, §9, ed. Schneider, *sec.* Houghton.
(215) *Ibid.* I., 6, §13. *Vide supra* "The Origin of Fungi," where the passage is quoted in full.
(216) Dioscorides, Mat. Med. II., 174, *sec.* Houghton.

to yellow; that it is dug out of the ground in the spring, and is eaten either raw or cooked.

Houghton[217] makes the following comments on the Greek names for Truffles: "With respect to the Greek words *ὕδνον*, *ἄσχιον*, and the Thracian *ἴτον*, and the *μίσυ*, the name of the plant near Cyrene, there is no clear etymology forthcoming. If *οἴδνον* is another form of *ὕδνον*, according to Liddell and Scott's Lexicon (but I can find no authority for its use in Theophrastus), then one would naturally refer the name to *οἰδέω* or *οἰδάνω*, "to swell," and the etymology would be sufficiently exact, answering to the Latin *tuber*. Aëtius and later Greek writers use the word *ἴτινον* for the truffle. Sibthorpe found the names *ὕδνος* and *ἴκνος* to denote this fungus in Greece, and Heldreich (Die Nutzplanzen Griechenlands, p. 2) gives *ὕδανον* or *ὕδνον* for the *Tuber cibarium* in the Peloponnesus, and *χοιρόψωμα* in Crete, adding that Truffles occur in woody places in Greece, but are not much sought after. According to the last-named authority, the ancient Greek name *ἄσχιον* for a Truffle is now used for a polyporus or a fungus generally, under the form of *ἴσκα*, Pelasg. *eské*, *éska*. The *μίσυ* must remain quite unexplained. Another Greek name is apparently used by Theophrastus to signify a Truffle, viz. *κεραύνιον*, but given by Athenaeus, who is quoting Theophrastus, as *γεράνειον*. I suspect *κεραύνιον* is the proper reading, and that it refers to the popular idea that such plants appeared chiefly after thunderstorms."

We have seen that Pliny[218] considered Truffles to be one of the marvels of nature because "they spring up and live without a root," and that he termed them an imperfection of the earth (vitium terrae). Concerning the different species he says: "There are two kinds; one is sandy and injures the teeth, the other is without any foreign matter (sincera); they are distinguished by their colours being red, or black, or white within; those of Africa are most esteemed." To the passage containing these words, which has already been quoted,[219] he added the following remarks: "The following accident happened a few years ago to Lartius Licinius, a person of praetorian rank, and a minister of justice at Carthage, in Spain, as I myself know: he was biting a Truffle and a denarius inside it bent his front teeth, from which circumstance it is evident that this natural production of the soil had originally assumed a globular shape, as is the case with those things which grow of themselves and are not able to arise from seed. Of a similar nature is that which is produced in the province of

(217) Houghton, Notices of Fungi in Greek and Latin Authors, *loc. cit.* p. 43.
(218) Pliny, Nat. Hist. XIX., 11. *Vide supra* "The Origin of Fungi," p. 31.
(219) *Ibid.*

Cyrenaica called *misy;* it is noted for the sweetness of its smell and flavour, and is more fleshy than the other kinds mentioned; that which is called *ceraunium* in Thrace, is of a similar nature." Finally he repeats what Theophrastus has said concerning the popular belief that Truffles are formed during thunderstorms and states that the best kind is obtained in spring.

From Pliny's remarks one gathers that *tuber* was the general name for Truffles, and that the *misy* and the *ceraunium* (mentioned first by Theophrastus) were particular kinds of Truffles. Tulasne[220] justly remarks that the species which was gathered in the spring, the *tuber veris* of Juvenal and others, is doubtless the *Terfezia Leonis* Tul. or *Terfez* of the Arabs, which grows in North Africa. In this connection, it will be remembered that Pliny says: "Those of Africa are most esteemed." Tulasne noticed that the surface of the base of the fruit-bodies of *Terfezia Leonis* often bristles with sand, which also gets into their substance.[221] Here again Pliny's words are brought to mind: "One kind is sandy and injures the teeth." For the other species, we have only the colour for a guide and the statement by Theophrastus that one at least was produced during autumn rains. It seems very likely, as Roze[222] suggests, that Pliny's Black Truffle *(Tuber colore nigro)* included such species as *Tuber brumale* and *T. melanospermum*, that his White Truffle *(Tuber colore intus candido)* may have been *Tuber Magnatum*, and that his Red Truffle *(Tuber colore rufo)* may have been *Tuber rufum.* Bicknell[223] states that he often noticed Truffles in the markets of Northern Italy, and that one of them was sold as *Tartufi bianchi* (White Truffles) at Bologna at four francs per pound. This highly esteemed species he identified as *Tuber Magnatum* Pico.

There can be no doubt that Truffles were considered by the ancients as among the most delicious of all fungi. The excellence of the North African *Terfezia Leonis* was celebrated by Juvenal[224] in some lines of a Satire which describe a stage in an elaborate feast, and which Houghton has translated as follows:—

"Then if the spring its genial influence shed,
And welcome thunders call them from their bed,
Large Truffles enter; ravish'd with their size,
'O Libya, keep your grain!' Alledius cries,
'O bid your oxen to your stalls retreat,
Nor, while you boast such Truffles, think of wheat!'"

(220) Tulasne, Fungi Hypogaei, Paris, 1851, p. 160 (*sec.* Roze).
(221) *Ibid* (*sec.* Houghton, *loc. cit.* p. 155).
(222) Roze, *loc. cit.* p. XXVI.
(223) Bicknell, Notes on the Edible Fungi of Italy, Woolhope Club Transactions, 1884.
(224) Juvenal, Sat. V., 116-119; Houghton, *loc. cit.* p. 46.

Martial[225] held that the Truffle was only slightly inferior to the lordly Boletus *(Amanita caesarea)*. In an Epigram he makes some Truffles exclaim: "We who, with tender head, burst through the earth that nourishes us, are Truffles, a fruit second only to Boleti":

"Rumpimus altricem tenero quae vertice terram
Tubera, boletis poma secunda sumus."

Galen,[226] the medical man, expressed himself in very much the same manner upon Truffles as he did on other fungi. He grudgingly admitted that they are good to eat but gave them no praise. He says that Truffles must be considered to be roots or bulbs; that they possess little flavour, should be eaten with spices, and are harmless; and that they possess a thick but not a noxious juice.

OTHER SPECIES.—Doubtless, in addition to the fungi which have been enumerated above, the old Greeks and Romans knew a number of other species which, however, did not possess sufficiently striking qualities to cause authors to mention them. Among the unrecorded species may have been: *Marasmius oreades*, *Cantharellus cibarius*, *Fistulina hepatica*, *Polyporus intybaceus*, *Hydnum repandum*, various species of *Russula* and *Lactarius*, etc. These are eaten in Italy at the present day and may also have been used as food in the time of the Roman Emperors.[227]

THE MISUSE OF CLASSICAL NAMES BY LINNAEUS.

Linnaeus was chiefly interested in the Flowering Plants and took but little interest in Fungi. He called them "beggars,"[228] "thievish and voracious,"[229] and said that "they seize upon the odds and ends which plants leave behind them when Flora is leading them into their winter quarters."[230] In the most

(225) Martial, Ep. XIII., 50.

(226) Galen, De Aliment. Facult. II., 68 and elsewhere (*sec.* Houghton, *loc. cit.* p. 46).

(227) Ovid, in one passage (Met. VII., 392-3), says: "Here (in Corinth) the ancients record that in the first age of the world mortal bodies were produced from fungi which spring up after rains":

"Hic aevo veteres mortalia primo
Corpora vulgarunt pluvialibus edita fungis."

Houghton (*loc. cit.* p. 25) suggests the fungus which originated this myth in the following words: "Considering the licentious nature of the people and the extent to which the worship of Aphrodite prevailed in the city of Corinth, which in all probability was introduced by the Phœnicians, is it possible that the *Phallus impudicus* suggested the mythological tradition?" It is certainly conceivable.

(228) Linnaeus, "Fungi vero Mendici," Amoen. Acad., ed. 1, Vol. VII., 1769, p. 370.

(229) & (230) Linnaeus, "furaces voraces. Hi Flora reducente Plantas hiematum, legunt relictas earum quisquilias sordesque," Syst. Veget., ed. XIII., s. Murreana, 1774, p. 3.

arbitrary manner the great systematist, towards the middle of the eighteenth century, misapplied the fungus names which were then existing.[231] He wrongfully took *ὕδνον*, which was the Greek name for a Truffle, and used it for the genus *Hydnum* to denote fungi with a toothed hymenium. The word *agaricum*, as we have seen, was the ancient name for a species of Polyporus which grows on trees, namely, *Polyporus officinalis*. Linnaeus took the word Agaricus and applied it to designate fungi whose hymenial surface is lamellose. From Pliny's description of the *boletus*, there can be no doubt that this name was originally used for one or more species of what we now call *Amanita*, i.e., a genus provided with gills; yet Linnaeus, following Dillenius and discarding the correct *suillus* of Micheli, applied the name Boletus to fungi whose hymenium consists of tubes. Finally, the word *helvella* which Cicero[232] used apparently to denote some dainty product of the earth which may or may not have been a fungus, without any good reason was used by Linnaeus for the genus which now bears its name. All these errors in nomenclature persist to the present day. Fortunately respect for priority does not extend to the times of the Greeks and Romans, so that we are not called upon to alter names which are now universally established.

Since the time of Linnaeus, Paulet alone has attempted to correct the mistakes which Linnaeus made in the use of the words Agaricus and Boletus. For *Agaricus* L. Paulet, in 1812, in his *Traité des Champignons*, substituted *Hypophyllum*, and for what we now, following Linnaeus, call *Boletus* he substituted *Tubiporus*.[233] Although these new names were well constructed, and from the descriptive point of view accurate, they were not accepted by other mycologists. This was doubtless due to the belief that, as the authority of Linnaeus was so great and his terminology so well established, any attempt to make a change would only lead to confusion.

(231) Linnaeus, Genera Plantarum, ed. I., 1737; ed. VI., 1764.

(232) Cicero, Ep. ad Fam., VII., 26.

(233) Paulet, Traité des Champignons, Paris, 1793. The names *Hypophyllum*, *Tubiporus*, etc., were not given in the text, but in the large Atlas which accompanied it and which was issued about 1812. This Atlas was published during a turbulent time in French history, and is very scarce: I have not seen it. In the second edition of the Atlas published by Léveillé (Paulet et Léveillé, Iconographie des Champignons, Paris, 1855) Paulet's specific names are set upon the plates. A synonymy of the names of Paulet and Fries is given by Laplanche, Dictionnaire Iconographique des Champignons Supérieurs, Paris, 1894, pp. 428-457.

CONCLUSION.

We have now come to an end of this first chapter in the history of Mycology. We have seen that the Greeks and Romans were familiar with a good many kinds of edible and poisonous fungi, that the Romans in particular developed elaborate recipes for cooking the most desirable species, that means were taken for dealing with cases of accidental poisoning, and that certain fungi had been discovered to possess medicinal properties. On the other hand, so far as the origin and mode of reproduction of fungi are concerned, the ancients were in complete ignorance. In general, they were contented to accept a theory of spontaneous generation, and they never even suspected that fungus fruit-bodies are simply reproductive organs. The spore dust, except doubtless in the Puffballs, appears to have entirely escaped observation.

JAPANESE MYCETOZOA.

PLATE I.

By Gulielma Lister, F.L.S.

It has been our privilege to receive during the past eight years a series of letters and specimens of Mycetozoa from Japan, sent by our friendly correspondent Mr. Kamagusu Minakata.

In 1906 Mr. Minakata wrote to the botanical authorities at the British Museum, sending them a package of Mycetozoa, and asking if they would be willing to name further specimens for him in return for his presenting the museum with as complete a collection of Japanese Mycetozoa as he could make. This offer was readily accepted.

Up to that time few Mycetozoa had been recorded from Japan. In 1902 a collection of eighteen species, made by S. Kusano in the Botanical Garden, Tokio, was sent to Prof. Marshall Ward at Cambridge; these were examined by my father and me:* one or two of the species had been found before in Japan. Until Mr. Minakata began his investigations these were the only Japanese Mycetozoa that we knew of; now, thanks to his energy and powers of observation, the number has been increased to 110 species, three of which were unknown before and have hitherto been found nowhere else, while much additional information has been gained as to the distribution of the species, the situations they frequent, and the range of variation to which the sporangia are subject.

The province of Kii, where most of the specimens were collected, is about the size of the county of Durham, and forms the most southern part of Hondo, the main island of Japan. It lies between lat. 33° and 34°, that is in the latitude of southern Tunis. The whole land is hilly and in the north-east wild and mountainous. No other district lying in the same zone has been studied in the eastern hemisphere with such thoroughness as regards Mycetozoa.

If we compare these species recorded from South Japan with those from Great Britain with its cool-temperate climate,

* See "Notes on Mycetozoa from Japan," by A. & G. Lister, Journal of Botany xlii., p. 97.

and those from Ceylon with its tropical climate, we find that 63 of the 110 species recorded for Japan have been obtained in Britain and Ceylon, 17 of them have been found in Ceylon and not in Britain, 18 of them have been found in Britain and not in Ceylon. From this we should infer that Japan holds a position intermediate between Britain and Ceylon in relation to its Mycetozoa, and this is probably true; but our assurance is tempered when we note that eleven species not yet recorded from Japan occur in both Ceylon and Britain, and we realize that further investigations are wanted before definite conclusions as to distribution of the different species can be attained.*

Before enumerating the Japanese species and commenting on those that are of special interest, I should like to say a few words about our correspondent himself, and give some extracts from his letters, which, written as they are in perfectly intelligible if rather unusual English, convey some idea of his enthusiasm, and of the dogged determination with which he has worked for science, regardless of personal inconvenience.

Mr. Minakata is a man of many interests and wide reading. He has travelled far afield, having visited Europe, England, the United States, and the West Indies. Besides Mycetozoa, he has studied fungi, algae, mosses, liverworts, and flowering plants; these studies have had to be pursued during the short intervals of engrossing business occupations. The neighbourhood of Tanabe, Kii, where he and his family live, is well suited for carrying on his scientific researches. He writes: "Even this small town of Tanabe is supplied with enough jungles and rubbish-heaps to repay industrious search—add to which its vicinity is richly studded with wooded hills, shady recesses as well as bosky temples."

It is unfortunate that the modern utilitarian spirit of Japan threatens to destroy many of the sacred groves here referred to; these, besides benefiting the climate, add much to the beauty of the country, and, with their ancient Shintô temples, have long been revered by the inhabitants. Feeling as he does the profound national importance of these temples and groves, with the sentiments they enshrine, Mr. Minakata has made strenuous efforts to save them.

He tells us that it was in a grove near the temple of the Monkey-god at Itoda, Kii, that he discovered the beautiful sea-green sporangia of *Arcyria glauca*, found hitherto nowhere else. On learning from my father that it was a new species, he wrote:—"About the date of last year's collection (June, 1906) I frequented the spot almost unceasingly and at last

* At the present time about 260 species of Mycetozoa are known; 163 species have been recorded for Britain, 105 for Ceylon.

succeeded in gaining this second gathering. It grows on the rotting wood of a huge Chinese Camphor-tree (*Machilus Thunbergii* Sieb. & Zucc.). Unfortunately our Government this year has put into effect an imperial decree obliging every minor Shintô shrine to remove and stand subordinate beside a more important temple in a near locality. This doom our Monkey-god could not escape, and the last spring he quitted his old site and removed to a new one close to a far bigger temple of the Fox-god in the neighbouring village. Indeed you and I must be very thankful to these animal deities, for their precincts have given us many Mycetozoa." Two years later, in May, 1909, he writes: "As to the Monkey-god of Itoda I must say I was stunned with despair on my return from a tour to find the whole grove that formerly added much to the sacredness of his shrine, entirely disappeared,—the preservation of the many hundred years' old Camphor tree being quite out of the question. The scenery has been totally destroyed. This sort of vandalism which is practised of late years daily in this country, would seem to result before long in the disastrous ruin of the patriotic as well as the aesthetic sense of the Japanese."

That the sorrow here expressed is a very genuine feeling is shown by a letter written in April, 1910. He writes:—"Since last September I am making a most strenuous protest against our governmental authorities, who are unceasingly demolishing our Shintôist temples of great antiquity, which vandalism is necessarily followed by the most lamentable annihilation of numberless animals and plants, which maintained their existence hitherto only under the protection afforded by the sacred groves; the avaricious local juntos hew down the trees and turn them into money. In March last a friend of mine, a member of Parliament, made a long speech on my behalf in our House of Commons, seconded by thirty-one members; the temple at Itoda was brought forward as one of the most regrettable instances of scientific loss. The same day our minister of civil affairs promised to order all local authorities thereafter to take most serious deliberation and precaution before demolishing any Shintô temple of antiquity and scientific interest." Notwithstanding this effort to obtain sympathy for his cause, his next letter shows that government action had not been vigorous enough to please him. He writes in 1911:—"I have been fighting for the preservation of the Shintô shrines and am now satisfied most of the learned in this country are becoming on my side. As my opposition was extremely vehement against the Government measures I was imprisoned for eighteen days last September, but was acquitted in consequence of clamours raised on my behalf." He adds:—"As a

memento of my suffrance of imprisonment for the cause of Science I picked a fragment of *Stemonitis* that I found growing upon an old post in the gaol, which is in one of the boxes I send you this time.'

From his last letter to me I gather he is still doing his utmost to prevent the destruction of what he feels to be priceless national possessions.

Other letters from Mr. Minakata describe in vivid and picturesque language his adventures in mountain regions when in search of specimens, interspersed with delightful digressions on local customs, and with stories of folklore beliefs still living enough in the minds of many people in lonely country districts. His descriptions of his specimens have a charm of their own from the poetic enthusiasm of the writer, whose awe and admiration are often evoked by the beauty of the minute objects of his search. Not unfrequently a pen and ink sketch accompanies the description to illustrate the situation in which some special sporangia had developed, or to explain some structural detail. Photographic views have also been sent us, showing the character of the scenery of some of his hunting grounds. Mr. Minakata has published two articles in the Botanical Magazine of Tokyo, giving an account of the Mycetozoa found in Japan.† They are written in Japanese, but the Latin names of the species are given, and in some cases short notes are added in English.

I will now refer to the collection sent us. No trouble has been spared in packing. Each specimen is firmly glued to the tray of a small pasteboard box, and of the 450 specimens we have received not one has come loose on the long journey. The small boxes were packed with camphor and cotton-wool padding in a large wooden box, which again was enveloped by many folds of paper and oilskin wrappings. The lid of each small box is marked with the number of the specimen, the place and date of gathering, the Latin name of the plant, if identifiable, on whose leaves or wood the sporangia had formed; where possible, the colour of the plasmodium is also noted. Rarely does he suggest the name of the species, though I think he generally has an idea what it may be, and he certainly knows if he has found it before. His sight must be amazingly good. In many cases the sporangia he sends are so minute that I see them only after search with a strong lens. He wrote recently:—"My eyesight might be excellent

† See "A List of Japanese Myxomycetes" in Botanical Magazine, Tokyo, xxii., pp. 317-322 (1908) and "A Revised List of Japanese Mycetozoa," l.c. xxvii., pp. 408-417 (1913). In the second article he enumerates 108 species of Mycetozoa for Japan; he has since added two more to the list. See also "Mycetozoa from Japan," by A. & G. Lister, Journal of Botany, xliv., pp. 227-230 (1906).

in power compared with others, but I know it is year by year declining."

The following is the list of the species he has sent us. Among his latest gatherings is one that appears to be an entirely new species, *Craterium rubronodum* I have named it; another is a new variety of the Japanese species *Hemitrichia minor* G. Lister, var. *pardina* Minakata, while another is a plasmodiocarp form of *Badhamia nitens*,—var. *reticulata*, met with several times before, and being constant differs sufficiently from the type to deserve varietal distinction.

Ceratiomyxa fruticulosa (Müller) Macbr., with its vars. *flexuosa* Lister and *porioides* Lister; abundant in summer.

Badhamia papaveracea Berk. & Rav.; one gathering in April, 1902.

B. nitens Berk. & Br. var. *reticulatum* nov. var. (plate I., fig. 2, 2a, 2b); found in June, 1913, on the living trunk of the Japanese Apricot tree (*Prunus armeniaca* L. var. *Ansu* Max.), 4ft. 6in. above the ground at Tanabe, Kii. The specimen consists of slender scattered sulphur-yellow plasmodiocarps, either long or short, curved or forming Q- and V-shaped figures; the yellow capillitium is of the usual *Badhamia* character; the spores adhere loosely in clusters of six to twelve, and are faintly warted with rather larger warts on the side turned outside as the spore lies in the cluster. This form of *B. nitens* with a plasmodiocarp habit and loosely clustered, faintly warted spores has been met with near Lyme Regis, in Poland, and in Ceylon. The Polish specimen was named by Rostafinski *Badhamia Alexandrowiczii;* the Ceylon specimen *Didymium reticulatum* by Berkeley and Broome; as the form appears to be constant, it seems worthy of varietal distinction; Berkeley's name *reticulatum* is descriptive of the branching net-like plasmodiocarps.

B. macrocarpa (Ces.) Rost.; found in January, 1907; the sporangia are either sessile or on slender buff stalks.

B. affinis Rost.; found repeatedly from June to September on the mossy trunks of living trees several feet from the ground. It is interesting that the Rev. Wm. Cran finds the inconspicuous scattered sporangia of *B. affinis* in exactly the same situations near Aberdeen.

B. orbiculata Rex.; found several times in summer and early autumn.

Physarum melleum (Berk. & Rav.) Mass.; frequent in the summer months, and observed developing from bright orange-red sclerotia.

P. variable Rex var. *sessile* Lister; gathered in May and September on fallen bamboo leaves and on old rope fibre. In one specimen the sporangia are pale yellow and grey; in the other they consist of long slender plasmodiocarps, orange yellow with a crimson groove down the centre. Mr. Minakata writes:—"The dorsal groove was at first crimson, all other parts are dark green as the skin of a water-melon; the whole appearance was something like a caterpillar or a serpent with warning colouration, and very awe-inspiring." The sclerotium was bright red and the plasmodium orange. This is the first record that we have, I think, of the colour of the plasmodium in *P. variabile.*

P. globuliferum (Bull.) Pers.; one typical gathering made September, 1902.

P. tenerum Rex.; found several times in summer, the plasmodium developing from primrose-yellow plasmodium.

P. roseum Berk. & Br.; found three times, in summer.

P. psittacinum Ditm. var. *fulvum* Lister; one gathering, July, 1906.

P. viride (Bull.) Pers., with vars. *aurantium* Lister, *incanum* Lister, and *rigidum* Lister; found from May to December, but especially abundant in summer. An irregular form of var. *rigidum* with sessile clustered and convolute sporangia was found growing on a species of *Polystictus*, associated with stalked and well formed sporangia; it developed from milky-white plasmodium.

P. polycephalum Schwein.; two gatherings, made in July and December.

P. Maydis (Morgan) Torrend.; two summer gatherings; these are entered in Minakata's list as *P. flavicomum* Berk. in consequence of our having named his specimen *P. Berkeleyi* Rost. (syn. *P. flavicomum* Berk.) before we realized that *P. Maydis* deserved specific rank.

P. citrinellum Peck; found twice in winter; these are the only gatherings obtained as yet beyond the United States.

P. nucleatum Rex; abundant in summer; one weathered specimen was found in November. This species seems to prefer a genial climate; the first British specimen was found near Looe, Cornwall, in July, 1911, by Dr. A. Adams.

P. pusillum (Berk. & Br.) Lister; three gatherings, made in summer; two specimens have long slender stalks and true "Physarum" capillitium; another has sporangia

with short stout stalks and capillitium consisting largely of branching tubules filled with lime granules; this form approaches the stalked variety of *Badhamia panicea* Rost.

P. didermoides (Ach.) Rost.; a single fine development found in July, 1912, "on an old straw rubber for cuisine" (apparently a straw brush from the sketch accompanying the description).

P. nutans (Pers.) Lister, with the subsp. *leucophaeum* Lister; abundant in summer and autumn.

P. crateriforme Petch; fairly abundant in summer on the bark of both dead and living trees; plasmodium dull ochraceous.

P. compressum Alb. & Schw.; abundant in summer on old straw, twigs and dead wood.

P. reniforme (Massee) Lister; found repeatedly in summer on dead wood.

P. cinereum Link; frequent in summer on dead leaves, with watery white or occasionally pale yellow plasmodium.

P. gyrosum Rost. Mr. Minakata gives a graphic description of his finding the dull yellow plasmodium in June, 1901. He writes:—"The plasmodium made its appearance after rain about five inches above the ground on the perpendicular wall of a basement of hewn stone of an outhouse." It formed a circular mass, two and a half inches in circumference. "From its quasi-central point something like arteries numerously and repeatedly branching were slowly pulsating, the ultimate branchlets terminating in a pus-like substance, botryoid and crowded. Later on it became gradually porous, the process being as if in fermenting action, the colour changing to light dull lateritious. It was only after its solidification that the olivaceous livid tint became permanent. I may add that a Chinese savant, Twang-ching-shih (who died 863 A.D.), writes in his Miscellany, Book X., folio 10b (Japanese ed. 1697), that a certain substance 'Kwei chi' (literally 'Demon's droppings'), growing in shady damp ground, of a pale yellowish colour, is occasionally met with, and is able to cure ulcers. Too brief for any scientific identification I am much of a tendency to suspect the old Chinese savant meant the plasmodium of some Mycetozoon, at least a single glance at the nascent stage of this specimen instantly brought to my mind the above-quoted passage of the learned Celestial."

P. sinuosum (Bull.) Weinm.; this is the form with small, much compressed sporangia; gathered repeatedly in summer.

Fuligo septica (L.) Gmel.; several gatherings, in spring and summer.

F. cinerea (Schwein.) Morg. Found on 'old straw nettings,' July, 1901. The gathering consists of smooth white corticate aethalia, with ellipsoid spores measuring 8μ × 14μ.

Erionema aureum Penzig. Found by S. Kusano in Botanic Gardens, Tokyo, September, 1902.

[*Trichamphora pezizoidea* Jungh. Mr. Minakata writes of having gathered a small group of sporangia on the dead wood of a living tree three feet from the ground, but he has not sent the specimen.]

Craterium minutum (Leers) Fries; one rather doubtful gathering consisting of pale weathered sporangia; possibly this should be referred to the following species.

C. leucocephalum Ditmar var. *cylindricum* Lister; found repeatedly in summer; in some gatherings the characteristic calcareous discs occur in the sporangium walls only, in others only in the lime knots of the capillitium.

C. concinnum Rex; two gatherings, one found on mossy bark, autumn, 1910, the other on the nest of a trapdoor spider on the ground, and on dead bamboo leaves, August, 1911. The sporangia developed from "milky then cream-coloured plasmodium." These are the only specimens we know of from the Old World. In North America the distribution of *Craterium concinnum* is said to coincide with that of the Chestnut, *Castanea sativa* var. *americana*, on whose burrs and stamen catkins the plasmodium feeds, and whose range is from the Eastern States to as far west as the Mississippi. I have recently heard from Mr. Hugo Bilgram that in the neighbourhood of Philadelphia a fungus is destroying all the Chestnut trees, and is spreading westward, and that *Craterium concinnum* is consequently threatened with extinction there, unless the plasmodium changes its diet.

CRATERIUM RUBRONODUM n.sp. (plate I, fig. 1, 1*a* to *d*). Plasmodium primrose-yellow then orange. Sporangia gregarious or scattered, stalked, goblet- or saucer-shaped, 0·2 to 0·4 mm. high, 0·2 to 0·6 mm. wide, smooth or slightly wrinkled longitudinally, pale buffish-grey or pearl-grey above, dark red-brown towards the base; lid convex or nearly flat with an upturned rim, white or pinkish-grey, smooth or slightly

wrinkled; sporangium-wall somewhat cartilaginous, pinkish-grey, including uniform deposits of lime-granules, and studded on the inner side with many small pouches, also containing lime-granules. Stalk dark red-brown, slender, 0·1 to 0·2 mm. high, sometimes absent, arising from a discoid hypothallus. Capillitium consisting of ovoid or irregular, rounded, pale brownish-red lime-knots connected by slender threads, and usually with a large central pseudo-columella; the latter is either irregularly ovoid and solid, or nearly smooth, spherical and hollow. Spores purplish-grey, 10-12μ diam., marked with scattered spines whose bases are sometimes connected by thickened lines to form a broken reticulation. Habitat: "Found in small quantity on dead bamboo leaves and rotting wood, on the ground, in company with *Craterium concinnum*, August, 1911." When I first examined this specimen two years ago I was struck with its resemblance to *Badhamia rubiginosa* both as regards the conspicuous columella and large rough spores. I wrote to Mr. Minakata suggesting that his gathering might be a variety of that species (see Minakata on *Badhamia rubiginosa* Rost. var. *concinnum* G. Lister *in litt.* Bot. Mag. Tokyo, XXVII., 408); but on re-examining the specimen I find that the mass of lime in the centre of the sporangium is not attached to the apex of the stalk as it is in *B. rubiginosa* and the lime-knots are too rounded and compact to belong to any Badhamia. Indeed the character of the capillitium, the lid-like cap to the sporangium, and the structure of the sporangium-walls are all in favour of its being placed in the genus *Craterium*. It is unlike any Craterium hitherto described, and although one hesitates to found a new species on a single gathering in the present case it seems unavoidable. The chief characters distinguishing the sporangia of *C. rubronodum* from those of *C. concinnum*, which they resemble in shape and size, are the presence of the large pseudo-columella, the large spinose spores, and the rounded brownish-red lime-knots; the latter become almost white as opaque objects after being exposed for some time to light, and then shine out among the dark spores far more conspicuously than do the small angular dull yellow or yellowish-brown lime-knots of *C. concinnum*. The specific name *rubronodum* is chosen in reference to the red colour of the

lime-knots. Although the sporangia have lid-like upper walls they break irregularly and not by a lid, as far as one can judge from the present specimen.

C. aureum (Schum.) Rost.; found twice in summer on dead bamboo twigs, leaves, &c.; the lime-knots in these specimens are either all free, or in part united to form a columella, which either is or is not connected with the apex of the stalk.

Diderma hemisphericum (Bull.) Hornem.; one gathering on bamboo leaves, August, 1911; the sporangia are discoid as usual and are unusually small, measuring 0·7 to 0·8 mm. diam.

D. effusum (Schwein.) Morg.; abundant in summer on dead leaves, wood and twigs.

D. arboreum G. Lister & Petch (Journ. Bot. li., p. 2, Tab. 524, figs. 2, 2a, 2b). This inconspicuous species seems to be not unfrequent in Japan. Mr. Minakata has sent us six gatherings, all found on the trunks of living trees in summer time. The Rev. Wm. Cran has also obtained *D. arboreum* in similar situations near Aberdeen in summer and autumn, every year since 1910.

D. testaceum (Schrad.) Pers.; gathered once, July, 1906.

D. ochraceum G. F. Hoffm. Two gatherings, both made in winter; one of them from Mt. Ando, 3,400ft. alt., has the sporangia grouped with those of *Lepidoderma tigrinum* (Schrad.) Rost., an association we have seen several times before in both British and American specimens, but what the relation of these closely allied species may be is still a mystery.

D. floriforme (Bull.) Pers.; one gathering, from the slopes of Mt. Ando, December, 1910.

D. radiatum (L.) Lister; the two gatherings, both made in winter, are of the form with pale drab sporangia dehiscing irregularly described by Persoon as *D. umbilicatum.* M. Meylan suggests that this name should be revived for convenience, although he hardly considers the form worthy of specific rank*; notwithstanding that it is more abundant than the type of *D. radiatum* which has brown sporangia dehiscing in petaloid lobes, it seems better to retain the pale form under that species as var. *umbilicatum.*

D. rugosum Rex; found on dead bamboo leaves and on the living trunks of pomegranate trees *(Punica Granatum* L.*)* in summer.

* See Meylan "Myxomycètes du Jura," in L'Annuaire du Conservatoire de Genève, 1913, p. 312.

Diachaea leucopoda (Bull.) Rost.; found repeatedly in summer on leaves; he sends also a fine gathering of the var. *globosa* Lister in which all the sporangia are globose.

D. cerifera G. Lister (in Journ. Bot. li., p. 3, Tab. 525); found in November, 1910, on Mt. Ando; this is the form in which the base of the sporangium is encircled by a thick collar of yellow wax. Mr. Minakata describes the sporangia as being " dull lead-colour with a weak metallic lustre "; he gathered this species again in 1912 but has not sent me any of the specimens.

Didymium difforme Duby var. *comatum* Lister; obtained in the Botanic Gardens, Tokyo, by S. Kusano, August, 1898.

D. Clavus (Alb. & Schw.) Rost.; two gatherings, one on the living bark of *Cinnamomum camphora* Nees, the other on dead bamboo leaves, both found in summer.

D. melanospermum (Pers.) Macbr. var. *minus* Lister; two gatherings, one with the usual dark columellae, the other with pale buff columellae enclosing much lime; these were obtained in May and July respectively.

D. nigripes Fries var. *xanthopus* Lister; abundant in summer.

D. squamulosum (Alb. & Schw.) Fries; fairly common in summer. In one large gathering with stalked, sessile or " plasmodiocarp " sporangia, the membrane investing stalks, columellae and hypothallus is pale reddish-brown; in other respects the characters are typical of the species.

Lepidoderma tigrinum (Schrad.) Rost.; found in abundance on Mt. Ando, in December, 1910. This species has never been found in the tropics, and seems to prefer a cool climate.

Colloderma oculatum (Lippert) G. Lister; about seventy sporangia found on Mt. Ando, December, 1910, on dead wood overgrown with scale-mosses. These are some of the largest and most conspicuous sporangia we have seen of the species; they are either thin-walled and iridescent purple-brown, or thick-walled olive-brown and glossy. On being placed in water the outer mucilaginous layer swells up as usual round the bases of the iridescent sporangia, but it appears to have lost the power of swelling in the brown sporangia where it persists as a hard oily-looking crust. Much of the purplish capillitium is very slender, and shows no differentiation into an outer sheath and central core such as is usually seen in this species.

Stemonitis fusca Roth.; abundant in summer and continuing to appear through the autumn and winter; the sporangia vary from 4 to 8 mm. in height; the plasmodium in one instance was blood-red in colour, instead of white: var. *trechispora* Torrend; three of the four specimens sent were found in winter, and have unusually tall sporangia, and stout capillitium; in the fourth gathering, made in July, the sporangia are only 3·5 mm. high; in all the specimens the spores are small, varying from 4μ to 6μ, and are marked with a lax reticulation of shallow bands: var. *nigrescens* Sturgis; two specimens of this dwarf form have been sent, both gathered in September; the surface net of the capillitium is very lax; the spores are closely reticulated and measure 8μ to 10μ diam.

Stemonitis splendens Rost.; abundant from summer to winter; some specimens show an approach to the form *fenestrata* Rex in which the surface net of the capillitium has rounded meshes bounded by broadly expanded threads: var. *Webberi* Rex; abundant; plasmodium usually cream-white, rarely sulphur yellow: var. *flaccida* Lister; one gathering, November, 1910.

S. herbatica Peck; not unfrequent in summer.

S. pallida Wingate; four specimens gathered in summer and winter and closely resembling *S. herbatica*.

S. ferruginea Ehrenb.; fairly common from June to November.

Comatricha nigra (Pers.) Schroeter; only one gathering, made in March.

C. Suksdorfii Macbr.; the evidence for this record is unsatisfactory, the specimen on which it was founded being probably an irregular form of *Lamproderma arcyrionema*.

C. laxa Rost.; two specimens gathered in June and October show small scattered sporangia, with very lax capillitium.

C. elegans (Racib.) Lister; three perfectly typical specimens sent, gathered in July and October.

C. pulchella (Bab.) Rost. var. *tenerrima* Lister; two gatherings, made in June and September: var. *gracilis* Lister; fairly abundant on dead wood in summer.

C. typhoides (Bull.) Rost.; not uncommon in summer, gathered also in February.

C. longa Peck; one gathering, made in Botanic Gardens, Tokyo, September, 1902.

Enerthenema papillatum (Pers.) Rost.; two gatherings both made in June.

Lamproderma arcyrionema Rost.; abundant in summer and on into winter; a remarkable variety with lax capillitium and spores darker than usual was found in December, 1906, on decorticated trunks at Kitadani, Kawamata.

L. scintillans (Berk. & Br.) Morgan; three gatherings, made in summer time.

L. columbinum (Pers.) Rost.; three magnificent specimens sent, obtained on Mt. Tamaki and Mt. Ando in November and December. This species apparently prefers a cool climate. Mr. Minakata describes the sporangia as "coloured and shining like the azure band encircling the eye at the tip of the tail coverts of the peacock."

L. violaceum (Fries) Rost.; this species is recorded in K. Minakata's list, but I have seen no specimen from Japan.

Clastoderma Debaryanum Blytt; one specimen found, associated with *Comatricha typhoides*, "on rotting logs by the seaside, August, 1901, Arahama, Kii."

Amaurochaete fuliginosa (Sow.) Macbr.; a single specimen, obtained on a felled Pine trunk, May, 1907.

Lindbladia effusa (Ehrenb.) Rost.; two specimens of the usual form are sent, gathered January, 1902, and June, 1908, and a third, remarkable for having the internal sporangium-walls much perforated and reduced to broad strands, as in *Enteridium:* var. *simplex* Rex; a single specimen found, with short-stalked narrowly cylindrical sporangia, densely crowded on a stout hypothallus; gathered August, 1903.

Cribraria aurantiaca Schrad.; three gatherings, made in summer and winter.

C. splendens Schrad.; a single specimen, gathered October, 1906, with long slender stalks, and rather lax sporangial net connected with the stalk by long ribs. This species seems to be hardly more than a weak development of *C. intricata.*

C. intricata Schrad.; both the typical form and var. *dictydioides* Lister appear to be abundant in Japan in summer and autumn.

C. tenella Schrad.; abundant in summer. Mr. Minakata describes the plasmodium as "oily blackish-brown, at first extending over the surface of rotten wood in an even layer 2 by 5 cm. in area," later it "coagulates into separate minute black globules which mature into perfect sporangia with stalks." He sends a card smeared with the plasmodium which is as dark as that of *Lindbladia.*

C. languescens Rex; two gatherings sent, gathered in May and October.

C. microcarpa (Schrad.) Pers.; not uncommon in summer. In a letter he describes the colour of the plasmodium as "greenish black"; in his list, published later, he gives it as "dull cream-colour."

C. purpurea Schrad.; one fine gathering, obtained on Mt. Ando, in December, 1910.

C. violacea Rex; a single specimen found on a waxy *Corticium* growing on the underside of a fallen tree, December, 1908.

Dictydium cancellatum (Batsch) Macbr.; fairly abundant in summer: var. *fuscum* Lister, common in summer, found also in winter.

Licea biforis Morgan; found twice, on dead wood and on decaying carpellary scales of *Cycas revoluta*, in summer. We are indebted to Mr. Minakata for the first note on the plasmodium of this very minute species; he describes the forming sporangia as "watery white, then dirty grey, then pale copper colour."

Tubifera ferruginosa Gmel.; fairly common from summer to winter.

T. stipitata (Berk. & Rav.) Macbr.; four gatherings sent, made in summer and early autumn.

T. Casparyi (Rost.) Macbr.; several large clusters of sporangia, the largest measuring 17·5 by 4 cm., were found in December, 1910, on coniferous wood by Kin-ichiro Nishio in the neighbourhood of Mt. Ando; each cushion-like mass of sporangia is invested by a firm cortex formed by the union of the stout lid-like apices of the component sporangia; the inner sporangium-walls are brilliantly iridescent; the columellae are less tubular than usual and consist for the most part of solid rods attached above to the centre of each lid, and connected with the lateral walls by a few slender branches arising at irregular intervals; sometimes the columella is represented by a sheaf of slender knotted strands held together by many oblique threads. Rex's suggestion that these columellae may be imperfect sporangium-walls seems in the light of the Japanese specimens to be an unlikely explanation of their origin, and they are probably as true columellae as are the somewhat similar structures often seen in *Brefeldia maxima*.

Dictydiaethalium plumbeum (Schum.) Rost.; found on rotting bamboo stems, on the ground, June, 1913.

Enteridium Rozeanum Wingate; found on dead wood, December, 1910, on Mt. Ando.

Reticularia Lycoperdon Bull.; a single gathering, made in October, 1909.

Lycogala flavofuscum (Ehrenb.) Rost.; found in the Botanic Gardens, Tokyo, August, 1899, by S. Kusano.

L. epidendrum (L.) Fries; not unfrequent; plasmodium rosy-pink, rarely white or yellow: var. *exiguum* Lister (see Minakata Bot. Mag. Tokyo xxvii. 415); two specimens, one gathered in the spring, the other in June; the latter was seen to develop from deep rose-red plasmodium; in both gatherings the numerous small aethalia are 1 to 3 mm. diam., drab or purplish brown in colour, and have pink spores; the pseudo-capillitium is smooth, not transversely wrinkled as in the type.

Trichia favoginea (Batsch) Pers.; one specimen, collected in May, 1902.

T. verrucosa Berk.; three specimens, all gathered in winter.

T. affinis de Bary; apparently common from June to December.

T. persimilis Karst.; one specimen found on Mt. Ando, in November, 1910.

T. scabra Rost.; two gatherings from Mt. Ando, in November and December, 1910.

T. varia Pers.; one specimen from Itoda, October, 1910.

T. decipiens (Pers.) Macbr.; found abundantly on Mt. Ando, December, 1910, otherwise apparently not common.

T. Botrytis Pers.; one specimen, on dead wood, November, 1903.

T. lateritia Léveillé; two gatherings, on dead wood, made on Mt. Yamato and Mt. Ando in November of 1908 and 1910 respectively. This form, although closely allied to *T. Botrytis*, under which it is placed as a variety in the British Museum Catalogue, is well deserving of specific rank. Apart from the redder colour of the elaters it differs from that species in the structure of the stalk. In *T. Botrytis* and its varieties, the wall of the stalk encloses a loose sponge-like tissue of narrow strands containing granular refuse matter; in *T. lateritia* the translucent red walls of the stalk enclose no sponge-like tissue or refuse matter; they are usually more slender, and more frequently combined in clusters.

Hemitrichia minor G. Lister. This minute species, recorded only from Japan, has now been gathered a number of times by Mr. Minakata. He finds the sporangia in various situations; on fallen branches, on the dead branches of living trees of *Citrus Decumana* at a height of five feet from the ground, and on living

trunks of *Prunus armeniaca*. The plasmodium is "watery-cinnamon" in colour. The sporangia are either globose and sessile or shortly stalked, or form slender curved plasmodiocarps. Growing apart from these, and also in some instances associated with them, he has obtained a remarkable variety in which the walls of the plasmodiocarps, instead of being smooth, are thickly spotted with prominent hemispherical or pointed blackish-brown warts; these warts when highly magnified are seen to consist of aggregations of dark refuse-matter on the surface of the ochraceous membranous sporangium-wall; the spores and capillitium of this variety are much as in the usual form, the capillitium threads are marked with four to five inconspicuous and often irregular spiral bands; the spores are bright yellow, minutely spinulose, 10μ to 11μ diam. On a card received last July Mr. Minakata writes:—"In June last I have obtained numerous specimens of the same leopard-like Mycetozoon on a Japanese Apricot tree in my garden, the same tree on which Myc. 432b *(=Hemitrichia minor)* appeared last year, and not only on the same tree, but on the same limb of it, the leopard-like specimens mixed with the smooth. They were smaller and with the scales more acutely raised, somewhat in the manner of the scales of the pangolin *(Manis)*, but I have no doubt all these three are one and the same species. Perhaps all the specimens before sent by me of *H. minor* are not quite developed fully, and the leopard- or pangolin-like ones are the very perfect growths of the species." For distinction he wishes that this spotted form should be given a name derived from the noun *pardus*, a leopard; I therefore call it var. *pardina* Minakata (Plate I, fig. 3, 3a to c).

H. clavata (Pers.) Rost.; fairly abundant from June to December.

H. Serpula (Scop.) Rost.; found nearly throughout the year.

Arcyria cinerea (Bull.) Pers.; apparently abundant in most months of the year; very variable in size and colour.

A. pomiformis (Leers) Rost.; found several times in summer.

A. denudata (L.) Sheldon; common in summer and autumn.

A. insignis Cooke & Kalchbr.; three gatherings sent, all made in summer. One of them is faded and of it Mr. Minakata writes:—"I think this is weathered *A. insignis*, though the colour is very unlike; I saw frequently growing on dead branches of the same tree, *Citrus Decumana*, four to six feet above the ground, an

abundance of well-developed rosy coloured *A. insignis*."

A. glauca Lister; two gatherings, both found on wood of the Chinese Camphor tree, at Itoda, Kii, June 1906, July 1907. This beautiful species has only been recorded from Japan hitherto.

A. stipata (Schwein.) Lister; one gathering made in June 1914, but the specimen was not sent me.

Perichaena chrysosperma (Currey) Lister; about six gatherings have been sent, gathered from June to December. The plasmodium is described as being "pallid tinged with yellowish-green," or "dull watery white, then greyish, then rufescent or pale pink." One large gathering, obtained on dead leaves of *Cycas revoluta*, shows considerable variation; the chestnut-brown sporangia are globose or reniform, and measure from 0·2 to 0·8 mm. diam.; they are nearly all provided with well-developed black stalks; the sporangium-walls break up into lobes and areolae along thinner lines of dehiscence. Of it Mr. Minakata writes:—"Very fragile; though very abundantly found, not one large sporangium remains now entire; only one of the hundreds was marked with a line of dehiscence above as if it were provided with a tightly-closed lid." The sporangium-wall is, as usual, somewhat cartilaginous, dull yellow, closely and very faintly papillose, and more or less overlaid with deposits of yellowish-brown granules; the capillitium in some sporangia is typical, yellow, spinose and 2μ diam.; in others it is 3μ diam., pale yellowish-brown, and either smooth or marked with irregular swellings and a few minute warts; the spores are 8μ to 9μ diam. Another gathering he sends consists of ochraceous-brown plasmodiocarps, with minutely warted dull yellow capillitium, without any of the characteristic spine markings; the spores are 9μ to 11μ diam.; the sporangium-wall is faintly papillose, as in the type. In the light of these variations I think we have proof that the specimens referred to in Brit. Museum Catalogue, p. 253, from Devon and Philadelphia, as *P. vermicularis* Rost. var. *pedata* Lister, are merely the stalked form of *P. chrysosperma* with weak and nearly smooth capillitium.

Margarita metallica (Berk. & Br.) Lister; three gatherings, made in June, August, and December, respectively.

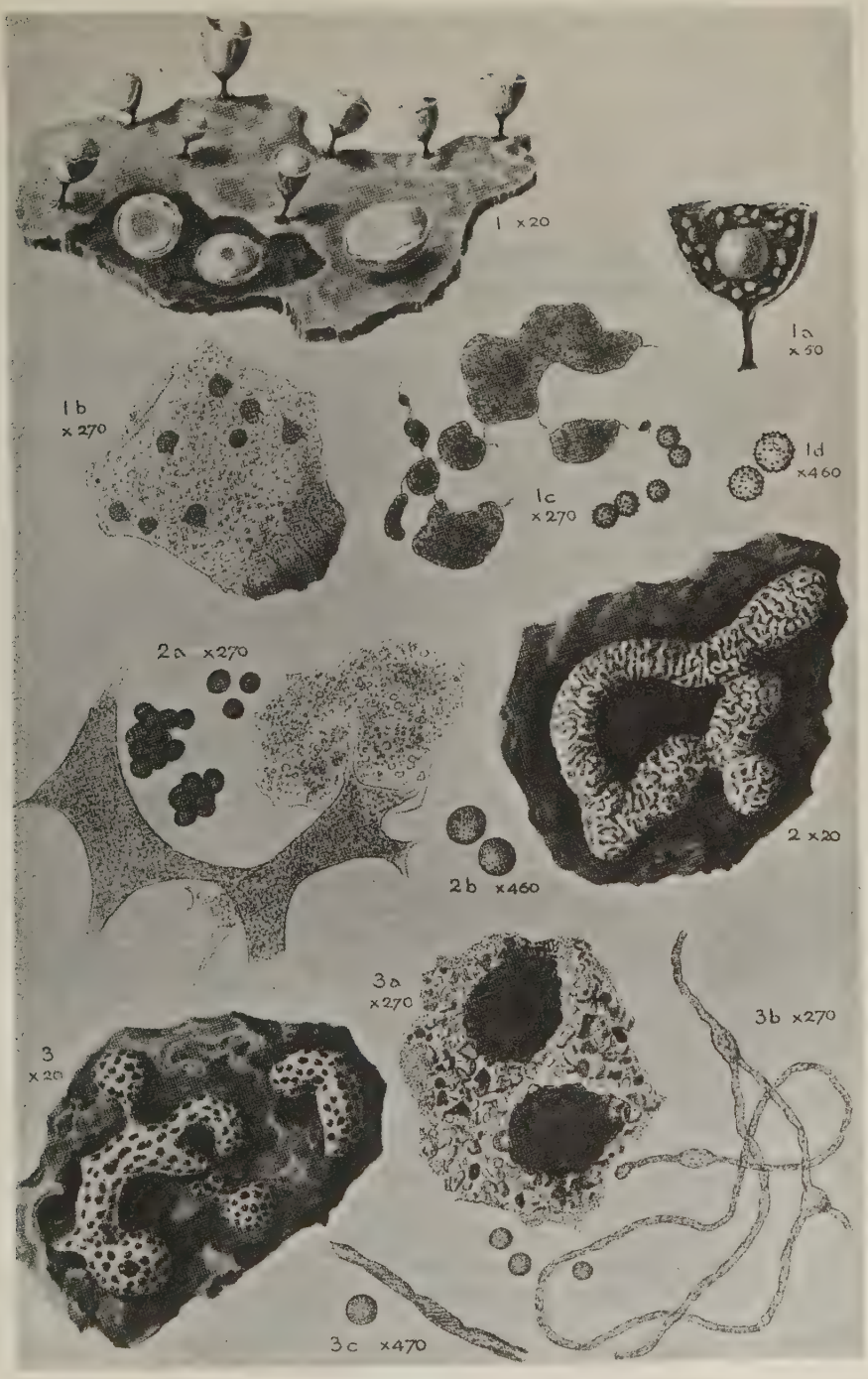
Explanation of Plate I.

Fig. 1. *Craterium rubronodum* G. Lister, group of sporangia

on a bit of leaf; 1a, sporangium with one half removed to show the spherical pseudo-columella and lime-knots; 1b, fragment of sporangium-wall viewed from the inner side showing pouches containing lime-granules; 1c, capillitium and spores.

FIG. 2. *Badhamia nitens* Berk. var. *reticulatum* (Berk.) G. Lister, plasmodiocarps; 2a, fragment of capillitium and sporangium-wall, with two clusters of spores and three free spores; 2b, spores showing greater roughness on one side.

FIG. 3. *Hemitrichia minor* G. Lister var. *pardina* Minakata, plasmodiocarps; 3a, fragment of sporangium-wall with two wart-like aggregations of refuse matter; 3b, capillitium; 3c, fragment of capillitium showing spiral markings, and spore.



G. Lister del. West, Newman proc.

1, 1a–d. CRATERIUM RUBRONODUM *G. Lister.*
2, 2a, b. BADHAMIA NITENS *Berkeley* var. RETICULATUM *G. Lister.*
3, 3a–c. HEMITRICHIA MINOR *G. Lister* var. PARDINA *Minakata.*

RECENT PUBLISHED RESULTS ON THE CYTOLOGY OF FUNGUS REPRODUCTION (1914).

By J. Ramsbottom, M.A., F.L.S., Department of Botany, British Museum.

During the past year special attention has been paid by investigators to the Uredineae. There are still many problems to be solved in this group and further work will doubtless reveal its true affinities. Owing to the present discontent certain publications have been inaccessible. Where these have contained papers dealing with the subject of this series, the writer hopes that they will be obtainable long before the writing of the next *résumé*.

PHYCOMYCETES.

Murphy (1914) has published a preliminary note on the morphology and cytology of the sexual organs of *Phytophthora erythroseptica*.* This species possesses a peculiar mode of development of the sexual organs in that the antheridium instead of growing up by and becoming laterally adpressed to the oogonium, is pierced by the developing female organ, which then grows through it and, rupturing the wall at the opposite side, emerges and assumes a spherical form. This method has been shown to obtain also in *P. infestans* and *P. Phaseoli* by Pethybridge and Murphy, and has been described quite independently by Dastur in *P. parasitica* n. sp. and in *P. Colocasiae* by Butler and Kulkarni.† Murphy has confirmed and amplified the observations of Pethybridge. The antheridia arise first as intercalary swellings, rarely terminally, and are cut off by septa. "The hypha in the act of giving rise to an oogonium may be seen not infrequently while still within the antheridium, having pierced one wall, but before it emerges at the opposite side." On emerging it is at first club-shaped, but quickly becomes spherical. When connections could be traced the male and female organs were always borne on separate hyphae but the fungus is homothallic. "When the organs are full grown the stalk or lower part of the oogonium lies within the anther-

* Pethybridge Sc. Proc. R. Dublin Soc. XIII., p. 529 (1913).
† *Cf.* Trans Brit. Mycol. Soc. IV., p. 319 (1914).

idium. . . . There is no trace of the antheridium growing around the base of the female organ when the latter is fully grown or nearly so." The oogonium at maturity is filled with dense protoplasm, in which are distributed a number of nuclei, which are at first elongated and irregular in shape, but afterwards round off and appear to increase in size. "About two-thirds of them then gradually disintegrate and disappear." At this time a thick plug is formed in the stalk of the oogonium. "Meantime the protoplasm of the oogonium has become less dense and less deeply staining, and the remaining nuclei, now larger and in the prophase of division, arrange themselves in the form of a hollow sphere with one in the centre. In this position all pass through a normal mitosis. The stages of the prophase, origin of the spireme, chromosome formation, and migration to the nuclear plate, are very clear. The spindle is intranuclear, but the membrane soon disappears. Centrosomes are present. The chromosome number is small but is very difficult to estimate with certainty, though it is probably about five. The oogonial nuclei undergo but a single simultaneous division." There is no differentiation into oospheric and periplasmic regions. As soon as the daughter nuclei are reformed all but one in the centre wander out towards the periphery, beginning to disintegrate rapidly at the same time: simultaneously practically the whole of the protoplasm contracts away from the oogonial wall and forms a uninucleate oosphere. The nuclei of the antheridium divide once, but whether this division was preceded by a disintegration of a portion of them was not ascertained. A very large 'receptive papilla' pushes its way from the upper part of the stalk of the oogonium into the antheridium. At about the period when mitosis is complete this has been entirely withdrawn, and a movement in the opposite direction begins, the fertilization tube, with a nucleus at the tip, growing into the oogonium. "The tube may pursue a somewhat devious course before penetrating the oosphere, which then ejects the tube and surrounds itself with a wall. The sexual nuclei, having increased enormously in size, appear to come together at first and then separate widely. When the spore wall is mature they approach again and fuse." The spore appears to rest in a uninucleate condition. Probably from the full account of this research much information with regard to the systematic position of *Phytophthora* will be obtained. The genus is usually classed with the Peronosporineae, but there a separation into periplasm and ooplasm is usual, a coenocentrum is generally present and often there are two nuclear divisions in the sexual organs. From the preliminary note it would seem that *Phytopthora* is more closely allied to the Saprolegniineae, though the morph-

ology of the sexual organs is unlike that known at present in any other Phycomycete.

Sporodinia grandis appears to share with *Pyronema confluens* the honour of being the most popular fungus for cytological study,* and there seems just as much disagreement as to the details. *Sporodinia* was the first fungus in which true sexuality was discovered, Ehrenberg (1820) giving the name *Syzygites* to the zygospores. The cytological work is referred to in previous papers in this series. Keene (1914) has published her observations on the fungus. The ends of certain aerial hyphae enlarge and fuse. Externally there is no difference between these two sexual branches, but in some cases one branch appears slightly smaller than the other, apparently owing to physiological rather than morphological conditions. The protoplasm flows into the ends until they are densely filled, while the regions further back are vacuolated. When the internal structure of the branches is studied, however, there is found to be a slight variation in the activity of the sexual branches. Léger described two types of branches: in one, the protoplasm fills both of the sexual branches, in the other the protoplasm is retracted from the wall. According to Keene "this appears to be due to a difference in age. In the earlier stages the protoplasm fills the branches, but later a retraction of the protoplasmic mass occurs. This retraction is usually restricted to one branch, but occasionally both show it to some extent. Even in the latter case, however, the retraction is more marked in one branch than in the other." No marked difference in differential staining between the protoplasts of the two branches was observed. A granular substance usually fills the intervening space where the protoplasm has drawn back from the wall. This is probably the substance described by Vuillemin which forms the secondary membrane before resorption occurs. Many nuclei are found distributed in the protoplasm of the young sexual branches. "Nuclear divisions were not observed, but there seems little doubt that they occur about this time, because there is a marked increase in the number of nuclei, which cannot well be explained on the basis of subsequent migrations." The nuclei are extremely small. The main part of the nucleus is granular in appearance: the central part appears to be a constant organized structure. "It is very similar in appearance to the nucleoli of the nuclei of the higher forms, but the fact that this structure is constant through all the stages of development would suggest that it is chromatin in nature rather than that it is a nucleolus. The true nature of this material will remain a question, however, until nuclear divisions have been

* *Cf.* Trans. Brit. Mycol. Soc. IV., pp. 132, 260 (1913-14).

observed." Lendner (1908) described the nuclei as being formed of two small masses closely associated, which divide simultaneously and give the double division described by Maire in the Basidiomycetes. Keene, however, was unable to find any variation from the ordinary structure in the nuclei of germinating spores where division must occur. Vuillemin (1903) and Dangeard (1906) have described the nature of the fusion of the contiguous walls of the gametangia. The two walls coalesce, forming a single separating partition between the two branches. Previous to the cutting off of the gametes from the suspensors, large vacuoles are formed a short distance back in the swellings, usually before the separating wall is resorbed. These vacuoles enlarge and become wedge-shaped: on the inner margins a narrow isthmus of protoplasm is left connecting the protoplasm of the suspensors with that of the gametangia. Towards the margin of the gametangium the point of the wedge-shaped vacuole cuts through the protoplasm forming a cleavage furrow that extends to the wall. "In some cases, the cleavage furrow appears to be cut in without the aid of vacuoles." The line of cleavage remains distinct and very soon a new wall is built from the outer wall of the gametangium. As the wall is built in, the circular opening is gradually closed, like a diaphragm, and cuts through the narrow isthmus of protoplasm. When the walls close, the cellulose-like material continues to pile up for a short time, forming a papilla-like projection which the remaining strands of protoplasm also tend to draw out. "The final cleavage is caused, either by the closing of the diaphragm, or by a furrow which precedes the new membrane so closely as to be indistinguishable. Thus it can be seen that this little structure that has received the passing attention of many, and had various functions allotted to it, is an unimportant result of the delimiting of the gametangium. In no cases have the orifices described by Dangeard and Léger been observed." As soon as the wall which separates the gametes from the suspensors is complete, and in numerous instances at the formation of the large vacuoles, the wall separating the gametangia is dissolved from the centre outwards. Meanwhile there is a marked activity on the part of the protoplasm which completely filled the one gametangium, while the protoplasm of the other gametangium shows a further retraction before the influx of the active protoplasm. The masses retain their individuality for a short time after the resorption of the wall and the region of contact reacts somewhat differently to stains. Ultimately the line of fusion is obliterated and it is impossible to distinguish any difference between the two masses. Gradually, as the mixing of the protoplasms progresses, it passes from a dense homo-

geneous nature to a vacuolar condition. "It is at this stage that occur what appear to be nuclear fusions." They are first evident along the line of contact of the two protoplasmic masses, and later throughout the whole structure as it becomes vacuolate. The nuclei come to lie in pairs, the nuclear membrane disappears between them, and the deeper staining central masses come to lie within a single membrane. Ultimately these fuse and one larger nucleus results containing a single deeply staining central portion. The question of course arises whether these stages may not be interpreted as divisions and not fusions. "The nuclei are so small that even under the highest magnification available . . . it is impossible to be absolutely certain on this point. There are, however, several resultant conditions that have seemed to justify the present interpretation. In the mycelium, in the germ-tube of the germinating spore, in the sporangia, and in the gametangia before resorption of the separating wall, the nuclei are small and not well defined. In later stages, however, the nuclei are larger, and the nuclear membrane is more distinct." The fusion of the nuclei results in the presence of nuclei of two sizes in the young zygospore. The protoplasm assumes a thready nature, and throughout the whole zygospore there is evidence of a nuclear disorganization, which appears to be restricted to the smaller nuclei. A characteristic zonation occurs about this time: the majority of the disintegrating nuclei appear to be concentrated in a zone around the periphery, while those toward the centre retain their normal form. When the nuclei begin to disorganize the outer membrane remains distinct for some time, but the inner portion loses its granular appearance: the central staining mass increases in size as if being dissolved and stains less densely, until finally the whole nucleus appears as a large staining mass. "The nuclei of the suspensors present a similar appearance as they degenerate, following the delimitation of the gametangium." About this time there appear numerous spherical bodies of cytoplasmic origin. These do not appear to be products of the disorganizing nuclei. They are generally globular in shape, are coarsely reticulate, and stand out as distinct individual structures. Many originate near the periphery of the zygospore but others are found through the central portion during the period of zonation. "The structures described by Léger under the name of 'sphères embryogènes' are most certainly identical with these bodies. Dangeard described them as 'chromatic corpuscles,' but did not study them closely, and arrived at no conclusions as to their function, apart from comparing them to the coenocentra of Stevens. That these bodies are not nuclei is evident upon a close study of their structure, and is more forcibly emphasized by their subsequent behaviour. They

gradually increase in size and number. . . . Fusions occur between them without reference to size or number. These fusions seem to be due to the rapid increase in size of the bodies, which causes a coalescence." As the structures enlarge they show a more definite organization, gradually losing their coarse reticulation, becoming sponge-like with a denser centre. In no case could anything that resembled chromatin or a nucleolus be detected within these bodies, and in no instances were the small nuclei found within these structures, but in all cases could the nuclei be seen in the meshes of the protoplasm between these structures and the vacuoles which are also numerous at this time. The structures continue to enlarge and fuse until after about six weeks there appear from one to three of these bodies. "Through tests with osmic acid and chloroform with fresh material, it is found that, from their first appearance, these plastid-like bodies are associated with the formation of oil." They become saturated with oil, which assumes their shape and is not always in the form of a definite rounded globule. The author suggests that the bodies may be related to the elaioplasts described by Zimmermann and others. Preliminary studies made by her on the oil bodies in the endosperm and cotyledons of *Ricinus communis* suggest a close resemblance between them and the plastids of *Sporodinia*. A comparison with the coenocentra present in many Phycomycetes leads the author to hold it as highly probable "that there is a close similarity between these structures of *Albugo* and the large oil plastids found in the mature zygospores of *Sporodinia grandis*." During these changes the nuclei persist in much the same form. "They are scattered through the cytoplasm, lying around and between the plastids as in the earlier stages. At the time of the appearance of the single large plastid, the nuclei are found in close proximity to the surface of the plastid. The protoplasm is found as a comparatively thin parietal layer in such stages, surrounding the plastid." Crystals are present in the earliest stages in the fusion of the sexual branches, and also in portions of the mycelium which the author interprets as mucorine crystals, so often recorded. "These crystals may be either reserve or waste substances. In the mature zygospore, there appears an irregularly knotted or densely granular substance of intensely red-staining material, aggregated for the most part on one side of the zygospore. It reacts to the stain much as the mucorine crystals . . . but also strongly suggests the disorganized nuclei. Until germination of the zygospores has been carefully worked out, however, the exact nature and function of this material will remain a question." The author hopes to shortly publish her work on *Rhizopus nigricans* and *Zygorynchus Moelleri*

where she is "convinced that the essential features are indentical with those of *Sporodinia*." The present account agrees with the researches of Dangeard (1906) and Moreau,* and apparently this process of multiple fusions and disorganization of the nuclei failing to fuse runs, with variations, throughout the Zygomycetes.

A genus of which the systematic position is doubtful but which seems closely allied with the Chytridiaceae is *Protomyces*. Büren (1913-4) has two short notes dealing with the biology development and cytology of this genus. In *P. pachydermus* the chlamydospore is multinucleate in the resting stage. The nuclei are small but a nuclear cavity and nucleolus can be clearly distinguished. The nuclei are uniformly distributed in the plasma and during germination retain this distribution when they pass over with the protoplasm into the sporangium. Vacuoles then appear in the protoplasm; the nuclei, and the protoplasm move to the periphery of the sporangium, where they form a layer which later falls into uninucleate portions placed perpendicularly to the surface of the sporangial wall. These uninucleate portions correspond to the spore mother cells as Juel (1898) has described in *Taphridium algeriense* "Zwischen diesen nackten Zellen konnte ich keine Zwischensubstanz wahrnehmen." The spore mother cells divide then into four spores, each possessing a nucleus usually occupying a polar position. The author up to the present has not succeeded in directly observing nuclear divisions; "dagegen sah ich in den Plasmaportionen zu wiederholten Malen deutlich das Resultat der Vierteilung."

In *P. macrosporus* Büren finds essentially the same cytological conditions except that the nuclei are distinctly smaller. In spite of their minuteness and poorness in chromatin he was successful in observing the divisions in the spore mother cell but could not be certain that a reduction division took place, because chromosomes could not be differentiated. He thinks it probable that such occurs, and a comparison with the size of the nuclei in the preceding stages supports this view. Popta (1899) described the development of the spores in this species as arising directly from the protoplasm without the intervention of spore mother cells: in the sporangium the spores contain one, two or three nuclei, and on dissemination five or six.

Sappin-Trouffy (1897) and Dangeard (1906), working with what they regard as the same species, found spores formed within the cysts in a large number of cases: in others germination occurs in the usual way. Active nuclear division takes place in the parietal layer, and after the last division two or

* *Cf.* Trans. Brit. Mycol. Soc. IV., pp. 132, 260.

three layers of uninucleate spores are formed. According to Büren the spores are always uninucleate when in the sporangium. "Wenn sie nach dem Austritt aus dem Sporangium mehrere Kerne aufweisen, so ist das durch eine nachträgliche Kernteilung zu erklären." The author states that he intends giving a fuller account in a future paper. In the earlier paper he states that *P. Kreuthensis* germinates in a similar manner to *P. pachydermus*. "Auch hier ist ein protoplasmatischer Wandbeleg, in welchem bis zur Bildung der Sporen verschiedene Umlagerungen stattfinden." This Popta also found in *P. Bellidis*. "Ferner habe ich bei *Pr. pachydermus* Thüm. und *Pr. Kreuthensis* Kühn noch eine andere Form der Sporenbildung beobachtet, bei der das Protoplasma direct in Sporen zerfällt, ohne vorher einen Wandbeleg zu bilden; dabei blieb ein Teil des Endosporiums in der Chlamydospore stecken." A fuller account with figures will clear up many points which are at present quite uncertain.

DISCOMYCETES.

Komarnitzky (1914) has investigated spore formation in *Verpa bohemica*, which is of interest in that the asci contain only two spores. The young ascus contains principally vacuolate epiplasm, only about one-tenth of its volume being occupied above by a dense granulate spore plasm. The epiplasm and in part the spore plasm also, contain glycogen. The nucleus lies practically in the middle of the spore plasm. It is of large dimensions, often 16μ in diameter, and takes up nearly the whole width of the young ascus. It possesses a well-marked membrane, a rather large nucleolus, and usually a clear chromatin net. In the spore plasm near the nucleus a large number of granules which stain like the nucleolus occur, many of them in immediate contact with the nuclear membrane. Carruthers (1911) found similar granules in *Helvella crispa* and considered they were split off from the nucleolus or nuclear framework. A similar method of origin was observed in *V. bohemica*, but their further fate was not followed: none are present at the time of the first division. Ascus development does not proceed simultaneously so that all stages are often present in the same section. Before the first division the chromatin contracts more or less to one side of the nucleus as a loose spireme. At the beginning of the division process the nuclear membrane disappears. Usually in Ascomycetes the membrane does not disappear until the anaphase, but an early disappearance has been reported in several species, *e.g.*, *Phyllactinia corylea* Harper (1905). The large size of the nucleus indicated that the nuclear divisions would be easy to follow. "In meinen Präparaten fand ich jedoch an Stelle der

karyokinetischen Figuren ein sonderbares Bild: die Chromosomen waren gar nicht zu sehen, an Stelle des sich teilenden Kernes waren nur achromatische Spindelfasern, der bedeutend verkleinerte Nucleolus und Centrosomen mit ihrer Polstrahlung zu beobachten." As the author used the ordinary methods of fixing and staining he is unable to suggest any reason for the apparent absence of chomosomes. The axis of the first division lies parallel to the long axis of the ascus, or somewhat oblique. In the telophase the spindle lengthens and the daughter nuclei form at a distance from one another which is greater than the diameter of the parent nucleus. The nucleolus appears in the interior of the newly-built nuclei but no chromatin net is formed. Soon after its formation the lower nucleus passes from the spore plasm into the epiplasm, frequently retaining traces of the polar rays which persist much longer in the upper nucleus. Usually at the same time, or a little later, the rest of the mother nucleolus is thrown out into the epiplasm, where it soon perishes. During its passage the nucleus becomes somewhat lengthened and in the epiplasm it may adhere to the ascus wall as Harper (1897) describes in *Erysiphe communis*, but generally it lies free in the ascus and gradually passes downwards. The upper nucleus increases in size and undergoes a second division, and one of the daughter nuclei wanders into the epiplasm, while the other, after a period of growth, enters upon the third division. "Über die Details der Karyokinesen kann ich nichts sagen, da die Chromosomen auch bei diesen Teilungen keine Färbung annehmen." The axis in the third division is usually transverse, as is generally the case in lengthened asci, and afterwards more or less follows the long axis of the ascus. The daughter nuclei separate somewhat. Centrosomes are present and the spores are formed in the manner first described by Harper (1897). The fate of the two nuclei which passed into the epiplasm could not be definitely ascertained. They continue their growth and sometimes they also undergo karyokinetic division. In the later stages of ascus development usually two or three nuclei are found in the epiplasm, though seldom more; the additional nuclei arise either by division or fragmentation of the original two. These nuclei are visible often for a long time after spore formation. The older the ascus the more indistinct and irregular the outline of these nuclei becomes and the less intensively do their nucleoli take up stain. Finally, they completely disappear. Each spore is more or less roundish when first formed, with its nucleus lying near the apex. They afterwards gradually lengthen and the nucleus wanders to the middle. "Wahrend der weiteren Entwicklung erfährt der Kern unzweifelhaft mehrmalige aufeinanderfol-

gende Teilungen, obwohl sich mir das direkt zu beobachten keine Gelegenheit bot." Successive divisions occur until the spore contains a large number of nuclei. The divisions proceed simultaneously in each spore so that, at all events at first, they contain the same number of nuclei. Multinucleate spores are quite common in the Helvellaceae, *e.g.*, *Morchella esculenta* has eight-nucleate spores (Maire). The fact that the spores of *V. bohemica* contain about a hundred nuclei is perhaps connected with their large dimensions. In this species there are slight variations in the number of spores, four spores and three spores (Sorokin) being occasionally met with. Asci with less than eight spores are met with in the Tuberaceae, Laboulbeniales, in some Erysiphaceae, and in certain species in other groups. In these cases three successive divisions of the definite nucleus of the ascus take place and the nuclei which do not go to spore formation disintegrate. In *Podospora anserina** Wolf found that there was no disintegration of nuclei, but that the wall of each spore enclosed two of the eight nuclei. The few spored yeasts and allied genera are suggested by these comparisons, but the explanation of their aberrations is still far from satisfactory.

The variations in the spores of *Bulgaria inquinans* are well known. The asci have been described as containing eight large dark spores similar in all respects: as only having four such spores: and as having four large spores with dark cutinised walls and in addition four small spores with hyaline walls. This dimorphism of spores is so frequent that it has been regarded by some as typical of the species though neither of the other conditions are rare. Tulasne was apparently the first who studied the germination of the spores. At first he was of the opinion that the four pale spores were abortive, but altered his view when he found that they were capable of germination. Various authors (de Bary, Brefeld, Biffen) have shown that these spores of small dimension, which appear withered and arrested in their development, germinate in much the same way as do the larger spores. Both when placed in water produce a short mycelium which soon bears conidia. The mycelium in the case of the pale spores is cylindrical and rarely produces more than two conidia: the dark spores give rise to a short, conical mycelial tube with a wide base which supports a larger number of conidia. The conidia arise as small buds which project at the surface of the mycelium. Sometimes the mycelium hardly ruptures the spore wall; in other cases the spore itself seems to give rise directly to the conidia. In water the conidia soon bud in a yeast-like manner and short chains of budding cells are produced.

* *Cf.* Trans. Brit. Mycol. Soc. IV., p. 145 (1913).

Moreau (1914) has investigated the species cytologically to find some explanation of this anisospory. "Le noyau des spores hyalines ne différant point par la taille du noyau des spores sombres." On the other hand, in the same hymenial layer asci are found of which the cytological history is different. There is first the case which is typical for the vast majority of Ascomycetes where the definitive nucleus of the ascus undergoes three successive divisions, a membrane forming finally around each of the eight nuclei. Thus arise the asci with eight isospores. The nuclei of the different generations are of different size, but all the nuclei of the same generation are of the same dimensions. The characteristic of this method is the synchronism of the mitoses. When the divisions are not simultaneous dimorphic spores arise. By noting whether asci have nuclei of different sizes one can often early distinguish those which will become heterosporous. In particular, asci with three nuclei, (a large nucleus of the first generation and two small ones of the second) are met with; the definitive nucleus has divided into two daughter nuclei only, one of which has further divided. Sometimes the two nuclei of the second generation divide in their turn before the second nucleus of the first generation has undergone any division. The ascus then encloses five nuclei, one large and four small. Other asci enclose six nuclei, of which four are small and two larger ones of the second generation. In all cases four nuclei are formed before the four others. They surround themselves with spore membranes. It is only later, when the four remaining nuclei are formed, that they surround themselves in their turn with membranes. By this time the first four spores will be large, having absorbed most of the epiplasm. Thus the last formed spores will be poorly nourished, which explains their small size and their frequent inability to germinate. The delay is not always so well marked as in this typical case, and the differences between the nuclei may be inappreciable to the naked eye.

In some cases less than eight spores are formed, owing to more than one nucleus being enclosed within a spore membrane. The spores are then of different sizes: e.g., in one case there were one large trinucleate spore, two medium binucleate, and one small uninucleate spores. Other variations are formed by having a number of larger binucleate and smaller uninucleate spores in the ascus. "C'est peut-être ainsi que se forment quatre spores binucléées chez les *Bulgaria inquinans* dont les asques sont régulièrement et exclusivement tétrasporés comme des auteurs dignes de foi en ont figurés." The enclosure of more than one nucleus in a spore has been recorded not infrequently in different Ascomycetes, but in most cases it can only be regarded as an abnormality. In *Podospora anserina*

Wolf* found that the four spores of the ascus each normally enclosed two of the original eight nuclei. *Bulgaria inquinans* seems much more liable to variation than any other Ascomycete of which we have yet had an account. "Dans la forme que nous avons étudiée ces phénomènes n'interviennent que d'une manière accidentelle et n'altèrent pas la généralité du procédé qui donne naissance au dimorphisme des ascospores du *Bulgaria inquinans*. Ce dimorphisme a pour origine l'absence de simultanéité des divisions des noyaux dans les asques et la concurrence qui s'exerce au sein de l'épiplasme entre des spores d'âge différent."

ERYSIPHACEAE.

Bezssonoff (1914), who has recently been studying the formation of conidia in the Erysiphaceae, now gives some new facts concerning the formation of the perithecium and the delimitation of the ascospores in that group. Perithecial formation has been studied in *Sphaerotheca mors-uvae*, and some observations have been made on the development of *Microsphaera Astragali*. As the sexual process of *Sphaerotheca* has been investigated by so many authors,† Bezssonoff abstains from giving a detailed description. The formation of the perithecium begins by the appearance of a group of cells which is the equivalent of the female branch; one develops into a female oogonium, the others, six in number, are joined on to it, two forming its base. The author suggests the term "oocarpe" for this oogonial complex. At the commencement of its differentiation the oogonium is almost of the same dimension as the other cells of the oocarp, but its final dimensions reach $10\mu \times 8\mu$, while the diameter of the other cells hardly attains $5{\cdot}5\mu$. A still larger difference exists between the dimensions of these cells and that of the cells covering the oogonium to which they have given rise, which have a diameter $1{\cdot}8\mu$ at the maximum. The pollinodium arises at the stage when the oocarp is at least bicellular. The septation of the pollinodium is preceded by nuclear division. The two young nuclei in *Sphaerotheca* have a very characteristic appearance. The nucleus of the apical cell becomes barrel-shaped and joins on to the summit of the oogonium. At the same time the walls become perforated and the cytoplasm of the male and female organs is put into direct communication. "Survient une division du noyau de l'anthéridie, amenant la formation de deux noyaux très petits en volume et dont l'un passe dans l'oogone, tandis que l'autre resté dans l'anthéridie, dégénère sur place quelque temps après le passage du premier." In *Sphaerotheca* the passage of the male nucleus has not been observed, "quoique sa présence à une

* *Cf.* Trans. Brit. Mycol. Soc. IV., p. 145 (1913).
† *Cf.* Trans. Brit. Mycol. Soc. III., p. 358 (1912).

proximité immédiate du canal copulateur, ainsi que les petites dimensions du second noyau de l'oogone, tout de suite après son apparition dans ce dernier, son aspect tout à fait semblable à celui du noyau resté dans l' anthéridie, enfin, l'existence d'une perforation entre l'anthéridie et l'oogone, mise hors de doute par l'emploi de colorants spécialement propices à la différenciation de la membrane . . . semblent indiquer l'existence du passage du noyau de l'anthéridie dans l'oogone." In *Microsphaera Astragali* the passage of the male nucleus into the oogonium was clearly established owing to the large size of the male nucleus, which greatly surpasses that in *Sphaerotheca mors-uvae* and almost equals the oogonial nucleus. The male nucleus which has passed into the oogonium (in *Sphaerotheca*) now gradually increases in volume until it is almost the same size as the female nucleus. "La fusion des deux noyaux de l'oogone de *Sph. m. uv.* n'a jamais été constatée. L'oogone de *Sph. m. uv.* évolue directment en un sac oogonal plurinucléé." The number of nuclei in this recurved sac has in some cases observed been as many as five. It has not been clearly established whether these nuclei arise by conjugate mitoses of the two primary nuclei or only by the divisions of the female nucleus. "L'ensemble de ces faits donne un fort appui à la théorie de Claussen, mais en suivant rigoureusement son schéma dans tous les détails, il se trouvera beaucoup d' autres faits, qui, comme on va le voir, seront bien difficiles à expliquer selon lui." The presence of a purinucleate unicellular sac has been recorded by Harper (1895) in *Erysiphe vulgaris*, but Dangeard (1897) denies its presence in *E. Martii*. In *Microsphaera Astragali*, Bezssonoff finds that the oogonium becomes septate immediately after the division of one of the two original nuclei. A multicellular ascogonium is formed, of which some cells are binucleate and others uninucleate. This gives rise to numerous hooked ascogenous hyphae, each composed of three cells, the middle one containing two nuclei.

The oogonial sac of *Sphaerotheca* transforms itself into a sharply curved ascogonium ("qu'on peut aussi désigner sous le nom d'hyphe ascogène") composed of six cells, the penultimate containing two nuclei. This binucleate cell gives rise to the ascus, while the other cells gradually disappear. "Les *processus cariokynetiques* qui accompagnent la fusion des deux noyaux du jeune asque n'ont pu être suivis avec assez de précision." At the commencement of the prophase of the first mitosis of the fusion nucleus, the chromatin is diffuse, the nucleolus is rounded, and the nuclear membrane is of uniform aspect. The chromatin then forms a twisted mass composed

of eight threads, the ends of which are attached to the nucleolus, two to each end and three to each side. The commencement of synapsis is marked by a contraction of the chromatin mass against the nucleolus which takes on an elliptical form. A longitudinal split which commences in the preceding stage is arrested by the synapsis. Degeneration of the nuclear membrane begins by its dissolution about the nucleolus and by the irregular swelling of the remaining portion. Four chromosomes appear on the maternal aster. Each of them is composed of two primary chromosomes joined end to end in pairs during the ulterior stage of synapsis, and has in consequence a curved appearance. At the stage preceding synapsis a mass of chromatic corpuscles appear within the nucleus and afterwards pass to the periphery at the opposite side to the nucleolus. "Ces corpuscules se soudent en un corps chromatique compact expulsé hors du noyau." A longitudinal fissure separates the chromosomes of the maternal aster into two polar groups, each with four chromosomes, which have the same shape as the parent chromosomes, V-shaped with long and slender branches. The first mitosis ends by the separation of the two polar plates. Neither centrosomes nor an achromatic spindle were observed in the course of this division. The second mitosis follows immediately. It begins by the formation of four chromosomes, which are in the form of irregularly shaped chromatic bodies, quite different from the chromosomes of the first mitosis. The four chromosomes of the equatorial plate fragment into eight, which form two polar groups each of four chromosomes. The nucleolus is elliptical in shape and an achromatic spindle is present, terminated by centrosomes. The second mitosis is followed by a well-marked period of rest. The four resulting nuclei surround themselves by a clearly differentiated membrane, the chromatin is diffuse and the nucleoli are round. The commencement of the third mitosis was not observed; eight chromosomes assemble on the equatorial plates leading to the formation of two polar plates of four chromosomes in the anaphase. "Donc, le nombre constant des chromosomes de l'asque du *Sph. m. uv.* est de quatre." In all probability four chromosomes are also present in *Microsphaera Astragali*, though the author's observations on this species are still incomplete. The differentiation of the spore plasm from the epiplasm begins by the formation of four clearly delimited masses (which the author suggests may be called *prospores*), each of which contains two nuclei and serves for the formation of two spores. These usually arise in the method described by Harper. Sometimes, however, certain interesting peculiarities occur. Thus in *Podosphaera leucotricha*, the division of the prospore commences by

the appearance of a groove in the middle parallel to the longitudinal axis. This groove soon enlarges, and by elongating reaches the opposite ends of the prospore and cuts it into two halves, each of which rounds itself off and becomes an ascospore. Although the prospores have well-marked contours they never have a special membrane.

The formation of the ascospore membrane commences in the neighbourhood of the nucleus. A certain relation exists between the fibrillar rays of the centrosome and the forming membrane. The author's observations agree with Sands' figures of *Microsphaera Alni*. "Néamoins, il est difficile de se rendre exactement compte du rôle des rayons archéoplasmiques dans la délimitation des spores." Centrosomes surrounded by fibrillar rays were observed, more or less clearly, only in the third mitosis. The spore plasm is distinguished by its great affinity for basic stains.

Ascospore formation was studied also in *Sphaerotheca Humuli*, *Erysiphe Polygoni* and *Uncinula Salicis*. They do not show any appreciable differences from what occurs in *S. mors-uvae*, "mais leur étude a permis de généraliser les résultats obtenus."

The author records some observations on chondriomes.

The chief point in which the present results differ from those of other observers is in the record of two male nuclei, one of which enters the oogonium, while the other remains in the antheridium and disorganizes. This recalls both Harper's and Dangeard's results. It is to be regretted that the fusion or otherwise of the male and female nuclei was not established, as that is the controversial point in those Ascomycetes with well-marked sexual organs.

PYRENOMYCETES.

Moreau (1914) has studied the development of *Peckiella lateritia (Hypomyces)*, which is parasitic on the gills of *Lactarius* spp., particularly *L. deliciosus*. The parasite in the case studied did not prevent the formation of spores in the host but did not allow of their dispersal. The stroma is formed of uninucleate cells. An ascogonium is present and begins as a short hypha composed of broad cells with a much denser protoplasm than that of the surrounding hyphae, and containing a large nucleolated nucleus. No antheridium is present. "Nous n'avons pas rencontré la moindre apparence d'une copulation ou même d'une mise en rapport avec un autre filament." The ascogonium soon coils, but the coils are always few in number and apparently never more than two. As the ascogonium grows it unrolls and its cells increase in number, though they remain uninucleate. A binucleate condition now

ensues. "L'ascogone, toujours enroulé, est alors formé de cellules nettement différentes des cellules des hyphes voisins par leur grande taille, la densité de leur protoplasme, les grandes dimensions de leurs noyaux: ceux-ci sont au nombre de deux par cellule; le noyau primitivement unique des cellules de l'ascogone s'est divisé sans qu' une cloison se forme entre les noyaux-fils." As an abnormality, division sometimes proceeds in such a manner that a cell contains three nuclei. When the ascogonium has developed so far, the neighbouring hyphae commence to form a regular layer of uninucleate cells around it, which later become denser and constitute a thick continuous layer. "Le cavité limitée par cette enveloppe est occupée d' abord par l' ascogone enroulé qu' accompagnent quelques filaments stériles aux cellules uninucléées qui par leur aspect nous paraissent indentiques à des hyphes quelconques du stroma." The ascogonium branches freely and forms a large number of binucleate cells in the cavity of the perithecium. As the perithecium becomes older it shows polarization. In the region near the surface of the stroma the binucleate cells give rise to asci; the cells become hooked and the nuclei undergo a division; two of the four nuclei are enclosed in a cell cut off by septa, and later fusing give rise to the young ascus. The nucleus of the young ascus undergoes three successive divisions in the usual way. The characteristics of *Peckiella lateritia* are therefore: "l'ascogone, dès le début cloisonné, est formé de cellules d'abord uninucléées, qui deviennent binucléées. Les hyphes ascogènes, aux cellules également binucléées, donnent des asques selon le mode en crochet." Moreau compares the method of ascus formation with that of *Aspergillus* and *Penicillium* where the ascogonial cells are also binucleate.* Uninucleate ascogonia are not frequent. Dangeard (1907) found the condition in *Chaetomium spirale* and *Podospora hirsuta:* in the former the cells later appeared to become multinucleate and doubtfully so in the latter. Maire (1905) investigated *Peckiella Thyriana* and found the cells of the mycelium and perithecial envelope uninucleate, but did not study the development of the perithecium although he records ascus formation as for *P. lateritia.*

Nienburg (1914) has investigated the development of *Polystigma rubrum.* The earlier investigations of Fisch (1882) and Frank (1883) had indicated the presence of a well-marked sexuality in this species—the fusion of a spermatium with a trichogyne connected with a coiled ascogonium. Blackman and Welsford (1912)† working with cytological methods did

* *Cf.* Trans. Brit. Mycol. Soc. IV., p. 266 (1914).
† *Cf.* Trans. Brit. Mycol. Soc. IV., p. 146 (1913).

not confirm the fusion of the spermatia with specially differentiated trichogynes proceeding from the well-marked ascogonia: they further recorded that the ascogenous hyphae arise by differentiation of purely vegetative cells and have no connection with the ascogonium. Nienburg has followed out the life history of the fungus and enters fully into those parts in which his interpretation is opposed to that of Blackman and Welsford. The development of the perithecium from the germination of the spore to the ripe ascus occupies about a year. Germinating spores placed on young leaves in spring produce, in five or six weeks, the stroma-building orange-red spots. Spermogonia are formed immediately, and a little later, July or August, the archicarp appears. Development at first proceeds very slowly and in December the fructifications occur on the dead deciduous leaves. The ascogenous hyphae develop, by comparison, rather quickly; by February young asci occur and the young spores are formed in March. Nienburg allowed the fungus to winter in his garden but no infection of plum trees followed. "Ein neuer Beweis dafür, dass sich der Pilz nur durch die Askussporen verbreitet und nicht etwa in den Knospen überwintert."

The archicarp first appears when the fungus has reached an appreciable size. The cells of the plum leaf are widely thrust asunder by the fungal hyphae, and only the upper and lower epidermis still build a continued layer. Only here and there are single, mostly dead cells of the mesophyll found, seldom containing protoplasm and a nucleus. In the light-coloured mycelium, the young archicarp occurs in the form of darker-coloured hyphal-balls with rich plasma content. The structure of this irregular coil is very difficult to make out in the younger stages. "Mit Sicherheit lässt sich nur sagen, das man Zellen mit zahlreichen kleinen und solche mit wenigen grossen Kernen feststellen kann." No trichogynes are present; the hyphae which project from the stomata are of purely vegetative character. This is shown not only by the fact that they have no connection with the archicarps but also in that they appear before the archicarps are present. The hyphae have obviously a great need of oxygen and bore everywhere in search of it, and preferably through the stomata on to the surface of the leaf. The vegetative mycelium changes into plectenchyma owing to equal sided pressure. At this time the essential parts of the coil can be clearly distinguished. Passing from the vegetative mycelium a small cell with few nuclei occurs. Then follows a long cell with many small nuclei, followed by a cell of similar shape but which contains only a single large nucleus. Next follows a much shorter cell with a rather large nucleus. At this stage three essential cells are always met with in the same

order: a long cell with many small nuclei, a long cell with a large nucleus and a short cell with a large nucleus. Following on after this the coil passes into a cell with an irregular number of small nuclei. These cells increase in number at a later stage and form the so-called trichogyne. This bends backwards and forwards and is difficult to follow. The coil loosens and winds irregularly. The fungus remains in this condition to the end of the year, the only change being that all the cells, both vegetative and reproductive, increase in size and show larger nuclei. The nuclei of each of the uninucleate cells possess large and clear nucleoli. The nucleoli in the multinucleate cell, though always present, are difficult to distinguish; afterwards they become clear and are always closely pressed against the nuclear membrane and sometimes even pass slightly beyond it, as Harper figured in *Phyllactinia* (1905). The cell which connects the long multinucleate cell with the ordinary vegetative mycelium is intermediate in character between the two. It resembles the vegetative cells in shape and size, but by its rich cell contents and the size of its nucleus resembles the multinucleate cell. The form of the nuclei is that usual in the vegetative cells, a pear-shaped structure with a nucleus at the point. This type of nucleus is not rare in the vegetative cells of fungi. At the trichogyne end the cells following on after the second uninucleate cell are always shorter and wider. The first is usually binucleate, and is followed by cells containing varying numbers of nuclei. There is a gradual diminution in the size both of the cells and of their nuclei. The latter are small without clear nucleoli, usually several in a cell, lying close to the cross walls nearest to the archicarp. "In den meisten Fällen gehen . . . mehrere Trichogyne von einem Archikarp aus und diese sind häufig noch wieder verzweigt."

According to Nienburg "ein typischer Sexualakt bei *Polystigma* auftritt." Only the two long cells of the archicarp are concerned in fertilization: the long multinucleate cell is the antheridium and the long uninucleate cell the ascogonium. In the centre of the wall between these two cells is a thinner spot, and here an opening later appears. "Von den zahlreichen Kernen des Antheridiums wandert nun ein einziger auf dieser Plasmabrücke in das Askogon." The author has not been able to obtain a preparation in which the male nucleus lies just in the opening. The two nuclei can be distinguished as the female nucleus has a large nucleolus. Before the migration stage, the female nucleus lies in the middle of the ascogonium, but when migration occurs it passes to the base of the ascogonium and lies against the wall away from the antheridium. Its nuclear membrane becomes indistinct and at the

moment of fertilization the nuclear cavity is generally scarcely visible. The membrane is gradually rebuilt. At the time of the migration the nuclei of the antheridium show striking changes. They enlarge somewhat and show a much clearer development of their chromatin element which differentiates now into separate thickened threads which for some time obscure the nucleolus. All the male nuclei undergo this modification and it appears to be a matter of chance as to which of them passes over into the ascogonium as the favoured nucleus is indistinguishable from the remainder. Immediately after the migration the opening between antheridium and ascogonium becomes closed. The male nucleus passes down the ascogonium. It first becomes oval and grows considerably. A few granules pass from the nucleolus and form a delicate chromatin net. The female nucleus begins to form a nuclear cavity. After a time both nuclei come to lie about the middle of the ascogonium and by then the male nucleus has so increased in size that the two are indistinguishable. "Ausserdem habe ich niemals zwischen Askogon und der nächsten einkernigen Zelle eine Öffnung oder eine dünne Wandstelle gesehen, noch habe ich in der zweiten einkernigen Zelle eine Teilung beobachtet. Ich halte deshalb die Möglichkeit, dass der zweite Askogon aus dieser und nicht aus dem Antheridium stamme, für ausgeschlossen." The cytoplasm of the ascogonium undergoes striking changes. In the young stages it is very dense, but when mature possesses a honeycomb-like structure with rather large meshes, which become smaller after the migration of the male nucleus. The cytoplasm of the vegetative cells becomes denser and nuclear divisions occur at the same period. "Der Sexualakt negt nicht nur das Askogon, sondern auch die vegetativen Zellen, aus denen später die Paraphysen hervorgehen, zu neuem Wachstum an." Now all the cells with the exception of the binucleate ascogonium degenerate. They first take stains greedily, so that the nuclei can no longer be differentiated. The cross walls swell into lens-shaped structures as in *Collema* after fertilization and in *Lachnea cretea*.* In no case, however, were openings found in the walls. The degeneration of the cells proceeds from the end of the trichogyne towards the ascogonium. The latter, which is typically spindle-shaped, shows now a dense cytoplasm with two nuclei with indistinct membranes. "Nach wie vor sind sie voneinander getrennt, eine Verschmelzung der beiden Sexualkerne tritt in Askogon nicht ein." The vegetative hyphae in the neighbourhood now grow vigorously. The membranes become extraordinarily thin and in many places

* *Cf.* Trans. Brit. Mycol. Soc. IV., p. 263 (1914).

cannot be differentiated. They begin also to transform themselves from plectenchyma into hyphae. "In der Umgebung des Askogons beginnen nun bald die vegetativen Hyphen sich in Paraphysen umzubilden." The growth tendency gradually passes to the higher lying portions of the mass, and as the hyphae have a vertical tendency the enclosing tissue complex passes from oval to pear-shape. The ascogonium remains still distinguishable by its thick cytoplasmic contents, but of its two nuclei only the large nucleoli are visible. As Blackman and Welsford pointed out, the fungus is unsuitable for the study of the ascogenous hyphae and the young asci. Nienburg was unable to find the first nuclear division. "Dass sie wie alle folgenden in den askogenen Hyphen konjugierte Teilungen sein werden, glaube ich daraus schliessen zu dürfen, dass ich in jungen Peritheciumanlagen häufig askogene Zellen mit je einem Kernpaar gefunden haben. . . . Es lässt sich also mit Sicherheit feststellen, dass die wiedergegebene askogene Hyphe in Verbindung mit dem Archikarp steht." The course of the ascogenous hyphae is diffcult to follow, as they bend irregularly and their lower portions become empty, the nuclei degenerating. The further development was not followed.

It is obvious that this account controverts the two principal points of Blackman and Welsford's paper, *i.e.*, that there is no fertilization and that the ascogenous hyphae arise vegetatively. According to Nienburg the "basal" cell of these authors represents the antheridium. Nienburg did not observe a fusion of the sexual nuclei and was not successful in finding the first division in the formation of ascogenous hyphae. He is of the opinion that the two nuclei do not fuse and that the nuclei of the ascogenous hyphae arise by conjugate division. The case would then resemble that of *Laboulbenia chaetophora* and *L. Gyrinidarum* (Faull 1912)*, and would also accord with what would be expected if Claussen's† theory holds throughout the Ascomycetes. The presence of a uninucleate ascogonium and a multinucleate antheridium is at present unknown in any other fungus. How is the fertilization to be regarded? Is it a reduced type similar to that in the Uredinales and the spermatia degenerate male structures as most mycologists have considered them? "Die Spermatien brauchen also nicht keimungsunfähig zu sein, weil sie einst eine sexuelle Funktion gehabt haben, sondern es ist auch möglich, das sie früher Konidien waren, die aus irgendeinem Grunde heute degeneriert sind." There is much to be said for the view of the conidial nature of the spermatia even in the Uredinales. In *Polystigma* can it be suggested that fertilization by a spermatium can be re-

* *Cf.* Trans. Brit. Mycol. Soc. IV., p. 150 (1913).
† *Cf.* Tom. cit. p. 140.

placed by a multinucleate gametangium of which only one nucleus functions? "Es ist das vielleicht möglich, wenn man annimmt, dass das jetzige Antheridium früher eine vegetative Tragzelle des Carpogons gewesen ist, die wie die übrigen vegetativen Zellen von *Polystigma* im Gegensatz zu den Asgogonzellen mehrkernig war. Diese ehemalige Tragzelle unterscheidet sich aber so auffallend durch Grösse und Inhalt von den übrigen vegetativen Zellen, dass auch in Erwägung gezogen werden muss, ob sie nicht etwa von jeher nichts anderes als ein Antheridium gewesen ist." The nearest approach to the conditions in *Polystigma* is seen, the author thinks, in the aquatic genus *Monoblepharis*, where there is a uninucleate oogonium and an antheridium containing many antheridia. *Polystigma* appears to have undergone a *volte-face* with regard to the origin of the Ascomycetes.

USTILAGINEAE.

Rawitscher (1914) has continued his investigations on the Ustilaginales. In his previous* contribution he dealt with the origin of the binucleate stage in *Ustilago Tragopogi*, *U. Maydis*, and *U. carbo*. His present paper deals with *Tilletia Tritici* and *T. laevis*. The cells and nuclei are here considerably larger than in the small spored species of *Ustilago*. Dangeard (1894) was the first to study the cytology of *Tilletia Tritici*. The copulation of sporidia in this genus was well known by the earlier workers being first observed by Berkeley. Whether this could be regarded as a sexual fusion was much debated. When the fusion of the nuclei in the mature spores was found the matter was further complicated, as no one has yet held that two sexual processes can occur in one life cycle. Rawitscher germinated the spores in water. A long germ tube is produced and the contents of the spore pass into it. The young germ tube in the investigated cases already contains eight nuclei, which evidently arise from the copulation nucleus of the non-transparent spore. The first divisions are "wahrscheinlich die Reduktionsteilungen." Eight sporidia usually occurred corresponding to the eight nuclei, but also frequently more, ten, twelve or sixteen, and each contained a nucleus, the germ tube previously containing the corresponding number of nuclei. When the sporidia are mature, two sister sporidia build between them the well-known copulation bridges through which the nucleus of one passes over into the other, in an analogous way to the sporidial copulation in *Ustilago carbo*. Long hyphae grow out of the copulated sporidia, possessing binucleate cells, and these can give rise to the so-called

* *Cf.* Trans. Brit. Mycol. Soc. IV., p. 154 (1913).

secondary sporidia, which also are binucleate. The infection of young wheat seedlings takes place by means of such binucleate hyphae, which grow in between the cells of the host plant. The further growth of the *Tilletia* was not followed as the wheat culture did not thrive. Maire (1902) however described the method by which the binucleate hypha gives rise to the spores in which nuclear fusion takes place.

There is thus no essential difference between the life history of *Tilletia Tritici* and *T. laevis* and that of *Ustilago carbo*. The constant appearance of the eight nucleate stage in both species (which had also been described by Dangeard) is interesting, as it reminds one of an ascus, whereas the external production of spores recalls a basidium.

Massee (1914) has made some observations on the life-history of *Ustilago Vaillantii*. The germ-tube of the spore on infecting a seedling, *Scilla bifolia*, enters along the line of the middle lamella and forms a mycelium which passes into the flattened stem at the base of the bulb, and continues to increase in quantity as the stem grows in size. Numerous haustoria, formed of short inflated branchlets crowded together and forming a botryoid mass, are present in the cells. Hyphae from the perennial mycelium enter the flower-stalk immediately it is formed and can be readily traced throughout its length, also in the pedicels and the filaments of the stamens. On entering the anthers the hyphae soon fill the pollen chambers and form numerous short branches which in due course give rise to the spores. "The vegetative mycelium is transversely septate, and each cell contains a single nucleus. Those portions of the mycelium which enter the anther-cells produce numerous short branches which are cut up into cuboid cells by transverse walls, each cell containing one nucleus: eventually alternate transverse septa deliquesce and disappear, thus leaving two nuclei in each cell. These nuclei fuse and form the single nucleus present in the mature spore. Soon after the fusion of the nuclei the wall of the mother hypha becomes swollen, and the protoplasm concentrates round the nuclei and forms the spores, which are fully grown while yet within the hyphal wall. Finally the deliquescent walls of the hyphae completely disappear, leaving a dry, dusty mass of spores." The account is not complete enough for much reliance to be placed upon it, as it is quite unlike anything previously described in the Ustilagineae.

UREDINEAE.

Kunkel has continued his investigation of *Caeoma nitens*.* The spores dusted on the surface of tap water in Petri dishes

* *Cf.* Trans. Brit. Mycol. Soc. IV., p. 277 (1913).

give good germination in spring at room temperature, but later in the season it is necessary to place them on an ice-box to secure abundant germination. In agreement with the observations of Olive (1908) and Kurssanow (1910) the normal aecidiospores were found to be binucleate, but occasionally there are rows of spores each of which contain more than two nuclei, whose size is roughly proportional to the number of nuclei they contain, "thus maintaining nucleo-cytoplasmic ratio." During the early stages of germination, previous to the production of promycelia, the spores become uninucleate. "A large number of spores have been studied with the hope that the actual stages in such fusions could be demonstrated The nuclei are clearly defined and can frequently be observed to lie close together and flattened against each other, but the actual breaking down of the membranes and the union of the chromatin reticula are hard to demonstrate. I find no evidence of disintegrating nuclei in any of the spores." The normal germination of the aecidiospore consists in the pushing out of a germ tube into which the contents of the spore pass, the nucleus becoming elongated during its passage. The nucleus soon divides, producing two nuclei which may again divide immediately or may round up and even become separated by a cross wall before the second division occurs. There is a suggestion that, as in *Endophyllum Sempervivi*, the first division may take place in the spore. The four nuclei of the promycelium may be present before cross walls are formed. "There is some evidence that these cell divisions take place by constriction, as has been reported in other rusts" (Holden and Harper (1903), Olive (1908)), but the point was not specially studied. The second nuclear division is soon followed by cell divisions, giving normally four cells, that are filled with protoplasm and contain one nucleus each, together with a stalk cell which is without a nucleus. "We have here a case in which a cell is cut off which contains no nucleus and may or may not contain protoplasm." When protoplasm is present it is massed at the upper end of the cell, leaving not even a vacuole and primordial utricle in the lower end. Promycelia were occasionally observed with more than five cells. Such mycelia, however, never produce more than four sporidia, and when they are stained show a nucleus in only four of their cells.

Sterigmata arise as pointed protrusions from the nucleated cells of the promycelium, generally near the distal end of the cell. After reaching a length of 15-20μ, the extreme end begins to enlarge, being at first almost spherical and afterwards taking on the shape of the mature sporidium. When the sporidium is about half its final size the nucleus enters it, becoming very much elongated in passing through the sterigma

but soon becoming spherical again in taking up a position near the centre of the sporidium. Generally the latter is shed before its nucleus divides, but sometimes nuclear division occurs while it is still attached to the sterigma. Nuclear division may occur in the sporidium either before or after germination, though it is generally binucleate at the time it germinates. It produces either a germ tube or a sterigma-like outgrowth, on which is borne a secondary mycelium.

"It is worth noting that if the aecidiospores are immersed in water rather than floated on its surface, they produce long tubes which are often devoid of septa. Such promycelia seldom produce sporidia, and might easily be mistaken for ordinary aecidiospore germ tubes. In cultures as much as two days old, these tubes regularly contain four nuclei. A study of earlier stages of germination shows that these four nuclei arise through two successive divisions of a single nucleus. This observation establishes the promycelial nature of these germ-tubes also. They are therefore not to be confused with the germ tubes of ordinary aecidiospores." Werth (1913) found similar non-septate germ tubes when he immersed the spores of *Endophyllum Sempervivi* and inclined to the view that under these conditions the aecidiospores produce ordinary germ tubes rather than promycelia. Maire (1900) described a variety *aecidioides* of *E. Sempervivi* in which the aecidiospores regularly produced germ tubes rather than promycelia.

Kunkel endeavoured to produce *Puccinia Peckiana* by inoculating *Rubus frondosus* plants with *Caeoma nitens*. His attempts were unsuccessful. An examination of *P. Peckiana* showed that the vegetative mycelium and the young teleutospores were binucleate and that the latter later became uninucleate presumably by fusion of the nuclei. On germination the promycelium consisted of five cells, a stalk cell and four cells that bear sporidia. Both cells of the teleutospore may produce promycelia simultaneously, but more often only one cell germinates. The mature sporidium falls off from the sterigma and under favourable conditions germinates immediately, producing either a germ tube or a sterigma on which is borne a secondary sporidium. "The development and germination of these spores leaves no doubt that they are true teleutospores, and that the aecidium stage of *Puccinia Peckiana* is yet to be determined." According to the author there can be no doubt that *Caeoma nitens* is a short-cycled rust which has no connection with *P. Peckiana*. Kunkel is "inclined to believe that *Caeoma nitens* is a rather primitive form among the rusts. The predominance of the gametophytic generation over the sporophytic generation is strong evidence in favor of this view. This is the condition which we generally meet

with in the lower forms of plant life. Those rusts in which the sporophytic generation has become the important stage are probably higher in the scale of evolution than such forms as *Caeoma nitens* and *Endophyllum Sempervivi. Caeoma nitens* should also be regarded as more primitive than *Endophyllum*, since it possesses a simpler form of aecidium." *P. Peckiana* has been placed in the genus *Gymnoconia* because of its supposed relation to a Caeoma type. It seems to the present writer that a new genus will have to be made for the state of things in *C. nitens*, of which the characteristics would be that it is of the type of *Caeoma* and its spores germinate as teleutospores, differing from *Endophyllum* in the absence of a well-marked peridium.

The various authors who have investigated the nuclear divisions in the Uredineae have given discordant accounts. Poirault and Raciborski (1895) first mentioned a nuclear division in the mycelial cells which produce the teleutospores in *Puccinia Liliacearum*, but they were not dealing with a single nucleus as they thought, but with the division of two conjugate nuclei. Dangeard and Sappin-Trouffy (1895) pointed out their mistake and described the simultaneous karyokinetic division of the nuclei, each nucleus with two chromosomes. Poirault and Raciborski (1895) concurred with this interpretation but held that each nucleus showed only a single chromosome. Sappin-Trouffy (1896) investigated a large number of Uredineae and recorded mitoses with two chromosomes. He did not distinguish centrosomes; he observed an achromatic axis, on the nature of which he did not pronounce, and which he compared to a small nuclear spindle. Juel (1898) described a rudimentary spindle in *Coleosporium Campanulae.* Maire (1902) confirmed the results of Sappin-Trouffy and of Juel, and considered the spindle of *Coleosporium* as the expression of the affinity of the Coleosporiaceae with the Basidiomycetes, especially the Auriculariineae. In more recent years several authors have recorded nuclear division with spindle and centrosomes not only in the Coleosporiaceae but also in the Pucciniaceae. In all cases more than two chromosomes have been recorded.

Moreau (1913)* recorded the presence of a centrosome in several species of Uredineae apart from nuclear division, and in her present contribution (1913) investigates what happens to the centrosome during the division of nuclei in the mother cells of the aecidiospores of *Phragmidium subcorticium* at the time when the aecidiospores separate from the intercalary cells. In the state of rest the nucleus is generally spherical. It

* *Cf.* Trans. Brit. Mycol. Soc. IV., p. 279 (1913).

possesses a rounded nucleolus either central or excentric, surrounded by a clear halo, a finely granular nucleoplasm, a visible nuclear membrane, and sometimes a centrosome situated on the external face of the nuclear membrane. When the nucleus is about to divide it stains more intensely and the chromatin of the nucleoplasm condenses into an arc usually situated against the nuclear membrane. The arc then elongates and soon splits into two elongated chromatin masses, and, at the same time, the centrosome divides. Sometimes the nuclear membrane disappears early, at other times it is still present when the chromatin fragments. The equatorial plate stage shows a clear spindle terminated at each extremity by a centrosome and showing two chromosomes in the middle. Each of the chromosomes divides and a later stage shows four chromosomes proceeding in pairs towards the centrosomes. Each pair contributes to the constitution of a daughter nucleus. "La division karyokinétique dans les jeunes écidies du *Phragmidium subcorticium* est donc caractérisée par la présence d'un fuseau, de deux centrosomes, de deux chromosomes, et par l'absence de membrane nucléaire." A division of the same type was found in elongated mycelial cells, which after the pairing of the nuclei give rise to the mother cells of the aecidiospores. The nuclei of these basal cells of the aecidium are smaller than the nuclei of the aecidia. They are moreover elliptical: the nucleolus, which is always very clear, is usually situated against the nuclear membrane, the nucleoplasm is granular and the centrosome almost always visible. "Au moment de la division on observe deux chromosomes, un fuseau et deux centrosomes comme dans l'écidie."

Moreau (1914) in a further note describes in the Uredineae "une division mitotique d'un type plus compliqué. Elle a lieu dans les téleutospores du genre *Coleosporium* au moment où celles-ci entrent en germination pour donner un promycélium interne bicellulaire, qui devient ensuite tétracellulaire." Sappin-Trouffy (1896) and Maire (1902) recorded the presence of two chromosomes in *Coleosporium Sonchi*, but Holden and Harper (1903) found from six to ten in the same species. Juel (1898) held that more than two chromosomes are present in *C. Campanulae* and Arnaud* (1913) similarly in *C. Senecionis*.

Moreau has investigated *C. Senecionis* and *C. Sonchi*. The nucleus of *C. Senecionis* has, in its resting stage, a reticulate structure. The prophase begins by the network transforming into a filamentous structure. The filaments which are in general fairly thin are very long and at first completely fill the nuclear cavity. They soon contract, slightly thicken, and

* *Cf.* Trans. Brit. Mycol. Soc. IV., p. 279 (1913).

undergo synapsis. "A ce moment on observe dans certains cas des filaments épais mêlés à des filaments minces; dans d' autres des filaments épais mêlés à des filaments minces rapprochés par paires; nous pensons qu'il y a peut-être à ce stade un accolement de filaments minces deux à deux donnant naissance aux filaments épais." The following stage shows only thick filaments—the "spirème épais." This unrolls progressively and at the same time splits longitudinally. "Par un épaississement et un raccourcissement progressifs ce dédoublement longitudinal donne naissance à des figures caractéristiques à deux branches diversement disposées l'une par rapport à l'autre: chacune de ces figures représente un chromosome à deux branches." At this stage the nuclear membrane disappears. The centrosome divides and the two daughter centrosomes pass to the opposite ends of an achromatic spindle which soon appears. By this time the nucleolus has generally disappeared. Each nucleus gives rise to two chromosomes with two branches: these place themselves in the middle of the spindle and constitute the equatorial plate.

The two branches of each chromosome afterwards separate, the figure enters into the anaphase and at this stage two chromatic masses are seen on both sides of the centre of the spindle passing towards each pole. These two masses are often double, for a longitudinal division of the daughter chromosomes generally takes place at the beginning of the anaphase. "Cette division longitudinale se continue; on peut alors compter huit masses—ou un nombre voisin de huit, car les divisions ne sont pas toujours simultanées—associées deux par deux, disposées le long du fuseau." Sometimes at this stage two centrosomes are present at one of the poles of the spindle, sometimes at both. It is perhaps a case of precocious division in view of the following nuclear division. On arrival at the poles the two daughter chromosomes are pressed together in such a way that at first sight each appears undivided. "La première division du noyau de fusion de la téleutospore du *Coleosporium Senecionis* est donc caractérisée par la présence de deux chromosomes à deux branches à la plaque équatoriale qui donnent quatre chromosomes-fils dédoublés longitudinalement à l'anaphase. Ce sont là les caractères d'une mitose hétérotypique." Moreau (1914) also gives an account of the second (homotypic) division in *C. Senecionis*. After the first mitosis two small daughter nuclei are present. Each of these possesses a reticulate nucleoplasm, a visible nuclear membrane, an extranuclear centrosome but no nucleolus: "celui-ci n'a pas le temps de se former car la seconde division suit la première de près." At the beginning of the second mitosis, the chromatin network transforms into very fine filaments forming a spireme

and the nuclear membrane disappears. Soon there is seen a nuclear spindle terminated at each extremity by a centrosome. The chromatin masses into a sort of ball on the middle of the spindle, and subsequently breaks into two portions which progressively condense: "et finalement donnent naissance à deux masses doubles, à deux chromosomes bivalents. A aucun moment de la contraction on ne constate de dédoublement longitudinal." These two chromosomes assume fairly often the shape of a V. The two branches of each V separate from each other at the commencement of the anaphase and constitute the four daughter chromosomes of the second kinesis. These chromosomes then pass in pairs towards the centrosomes, each being slightly hooked at the end furthest from the equator of the spindle. On arriving at the poles they become the two chromosomes of the daughter nuclei which show later a finely reticulate structure. The two divisions in the germinating teleutospore thus give rise to the four nuclei of the internal four-celled promycelium. "Cette second mitose ne comporte pas de division longitudinale des chromosomes; elle est essentiellement caractérisée par la séparation des branches de deux chromosomes doubles qui se montrent doubles dès qu'ils apparaissent; c'est une mitose homéotypique. . . . La première cinèse dissociant les chromosomes hétérotypiques en leurs deux branches constituantes effectue réellement la réduction; elle est donc 'euméiotique'; la deuxième est équationnelle."

A further paper by Moreau (1914) concerns the "prétendu trichogyne" of the Uredineae. She studied the young aecidium of *Phragmidium subcorticium*—"une nouvelle interprétation des cellules stériles vient de nous être suggérée par l'étude." On examining a rose leaf attacked by *Phragmidium* in spring, uninucleate mycelial filaments are found forming stromas under the epidermis, some of which give rise to spermogonia, others to aecidia. "Mais alors que beaucoup de spermogonies sont déjà mûres les écidies qu'on trouve à côté sont encore à leurs premiers développements qu' une étude attentive permet de suivre." At the spot where an aecidium developes the hyphae form a mass of uninucleate cells under the epidermis of the leaf. The mycelial cells nearest the epidermis soon elongate, forming a palisade-like layer of uninucleate cells perpendicular to the epidermis. Their nuclei then divide and a wall is formed between the daughter nuclei giving rise to two cells of unequal size; the upper or sterile cell is much smaller than the lower or fertile cell. The sterile cell degenerates: its protoplasm, at first fairly dense, soon be-

comes vacuolar, then quite clear, with only a few "traînées granuleuses": its nucleus diminishes in size and disappears. Usually only a single cell is cut off from the lower fertile cell, but a second cell may be cut off, sometimes a third, or even a fourth. "Quand plusieurs cellules stériles sont ainsi produites c'est généralement aux points de rencontre des cellules épidermiques, c'est-à-dire où il y a de la place." In one case Moreau met with a sorus of such cells which contained about twenty basal cells, each surmounted by two or three sterile cells—usually three. The sorus extended for a length of two epidermal cells and in the space between the two epidermal cells four sterile cells could be counted. In *Melampsora Lini*, Fromme* recorded the constant presence of two sterile cells, but these arise from the division of the single sterile cell, whereas in *P. subcorticium* "toutes les cellules stériles naissent aux dépens des cellules basales qui découpent successivement à leur partie supérieure une première petite cellule, puis une deuxième, puis une troisième et même une quatrième." All the sterile cells degenerate, but those first formed can be seen flattened against the epidermis with a degenerated nucleus, while the one last formed, which adjoins the basal cell, still shows a normal nucleus. The sterile cells are therefore produced in chains by the action of the basal cell, just in the same way as the aecidiospores are afterwards formed. "Par la manière dont elles naissent elles sont comparables aux cellules-mères des écidiospores et nous les interprèterons volontiers comme des spores dont la production précède celle des écidiospores." This structure which precedes the formation of aecidiospores is given by Moreau the name "*préécide*": it produces a kind of spore which is the trichogyne or buffer cell. "Nous serions donc disposée à croire que les préécides représentent une forme de frutification homologue des spermogonies et que leurs spores, cellules stériles ou *préécidiospores*, sont en réalité des gamètes que fécondaient les spermaties autrefois fonctionnelles." The preaecidiospores are the female homologues of the spermatia: both arise in sori, where they are produced in chains by the functioning of elongated basal cells; both are uninucleate; both are cells which have lost their character as gametes. Moreau finds some support for her hypothesis in an observation of Kurssanow (1910) in *Puccinia Peckiana*, where the sterile cells were sometimes found to detach themselves from the basal cells and lie in the space below the epidermis for some time before they disappeared. In *P. subcorticium* the end of the preaecidium coincides with the fusion in pairs of the basal cells by Christman's method. "Les cellules basales de la préécide—qui deviennent celles de l'écide après la duplication

* *Cf.* Trans. Brit. Mycol. Soc. IV., p. 159 (1913).

des noyaux—et les cellules basales de la spermogonie nous paraissent être des gamétophores provenant de la transformation de gamétanges analogues à ceux que l'on rencontre chez les Ascomycètes les plus primitifs."

Fromme (1914) has investigated the morphology and cytology of the aecidium cup in several species of rust. Although examples of both the caeoma and cup types of aecidia have been studied with regard to the nature of their sexual processes the clearest accounts have been given for the less complicated, superficial caeomas. "No comprehensive cytological account of the stages in cup-formation or of the general morphology of the aecidium has been given." "Besides the question of sexuality, there are a number of unsettled points relating to the morphology of the aecidium cup. Some of these questions were raised by de Bary and have as yet not been completely settled. For example, does the cup enlarge by the addition of new spore chains between those previously formed, or are the new chains added at the lateral borders? Is the peridium formed from the peripheral chains only, or are the central chains also involved? Do buffer cells similar to those found in the caeomas also occur in the aecidium cup?" De Bary stated that the hymenium of *Aecidium Berberidis* broadens before the cup completely matures, but he was not able to determine how this was brought about. He stated that the peridium arises from the marginal "basidia," and the entire outer chains composed of peridial cells arched over the centre of the cup to form a covering for the central spore chains. The description of the formation of the peridium given by most recent authors agrees with that of Richards (1896), who found that the growth of the hymenium was largely at the periphery, and that only rarely were new chains added between those already formed: he states that the peridium is formed from the apical cells of the central spore chains and from all the cells of the peripheral chains. Peridial cells are first formed at the centre and then successively on all sides of this centre until a complete protective layer is formed over the entire mass of spores. Dittschlag (1910), working with *Puccinia Falcariae*, was the first to describe sexual fusions in a cup-like aecidium.

Fromme in his present study treated *Puccinia Claytoniata*, *P. Violae*, *P. Hydrocotyles*, *P. Eatoniae*, *P. angustata* and *Uromyces Caladii*. *P. Violae*, *P. Hydrocotyles* and *U. Caladii* are eu-autoecious forms; *P. Eatoniae* and *P. angustata* eu-heteroecious forms; and *P. Claytoniata* is an *-opsis* form. "In three of the species the aecidia are borne on a mycelium that is diffused throughout the tissues of the host. In the other three the mycelium is localized within a rather restricted area.

These two types of aecidia can usually be distinguished at a glance. The aecidia from a diffused mycelium are distributed uniformly over the leaf or stem surface at approximately equal distances apart, and all on one part of the host are usually at the same stage of development. When the mycelium is localized, the aecidia are crowded together in groups, often with an annular arrangement, and the older ones are found in the center of the group and the younger at the margins."

Puccinia Claytoniata proved to be an exceptionally favourable form for study. The cells and nuclei are large and the vegetative mycelium that precedes the formation of spermogonia and aecidia is especially abundant and conspicuous, being found in all the leaf tissues, but more abundantly in the mesophyll near the lower epidermis. Most of the hyphae have their axis of growth in the long axis of the leaf. They are almost entirely intercellular except for the haustoria, which are short, knob-like, and usually penetrate only a short distance into the host cell. The hyphae are somewhat irregularly septate, the individual cells varying considerably in size. A single globular nucleus is located usually near the centre of the cell; its diameter is but slightly less than the short diameter of the cell. The nucleolus is small but readily seen, and the chromatin is distributed in small globular masses that are connected by delicate strands. These often appear to be orientated on a point on the nuclear membrane, as Olive (1908) found, but the presence of a central body was not ascertained with certainty. The hyphae branch monopodially at irregular intervals, the branch usually arising in the lateral wall near the apical end of the cell. "Binucleated cells were sometimes found in the vegetative mycelium, and continuous filaments of these were found in some cases. It is probable that the sporophytic mycelium had already established itself, and that both gametophytic and sporophytic mycelia were associated together in the same leaf tissue." The aecidia are hypophyllous. The first evidence of their formation is a conspicuous massing of hyphae between the lower epidermis and the first, second and third layers of mesophyll cells. The centre of the young hyphal mass lies between the first and second cell layers. The hyphae are conspicuous on either side of its centre for a distance of about two host cells. The area to be occupied includes in cross section twelve host cells, four cells broad and three deep. These host cells are gradually destroyed and replaced by the fungal hyphae. The host cells in the centre of the area are the first to disappear. The hyphae ramify between them and multiply in the intercellular spaces. "After these host cells have been completely cut off, they gradually diminish in size, and in most cases completely disappear eventually. The

hyphae do not penetrate the host cells during their disintegration, and their disappearance seems to be due to the pressure brought to bear on them by the enlargement of the fungous mass. Their walls soon become much convoluted and infolded. The host cells are not always completely destroyed; sometimes they may be found imbedded in the tissue of an old aecidium." The individual filaments have their direction of growth toward the centre of the mass, a point that usually lies between the first and second layers of host cells. "Not all of the hyphae are able to reach the center of the mass. Those on its lateral surfaces are crowded out by the earlier formed hyphae within and grow toward the epidermis, encircling the surface of the hyphal mass. There are five or six layers of these encircling hyphae." The cells that make up the hyphal mass of the young cup are shorter and broader than those of the vegetative mycelium. Their cytoplasm is more dense and stains more deeply. "This is particularly true of the cells of the interior, while those on the surface of the mass are less sharply differentiated from the purely vegetative cells. As the mass increases in size with the continued destruction of host cells, the fungous cells at the center begin to disintegrate. The first evidence of their disintegration is seen in the appearance of vacuoles in their cytoplasm. This is accompanied by the disorganization of the nucleus. They become detached from the hyphae on which they are borne and round up and enlarge to two or three times their original size if sufficient space is available. Some of these cells evidently undergo complete disintegration, while others become almost entirely empty except for a few cytoplasmic shreds and the remnants of the nucleus, and remain for some time in the center of the mass. They often become closely packed together as the result of enlargement, and have the appearance of a parenchyma. Because of this condition, this tissue of sterile cells is known as the pseudoparenchyma of the young cup." The first pseudoparenchyma cells formed are the apical cells of the converging hyphae, and disintegration proceeds towards the base. The apical surface of the mass is soon reached and the sterilization of the hyphae continues towards the lateral and basal surfaces. "The cells beneath the pseudoparenchyma are shorter and broader than those on the lateral and basal surfaces of the mass, their nuclei are larger, with larger nucleoles, and their cytoplasm is considerably denser. Several layers of hyphae at the base of the figure that run tangentially to the curved basal surface of the mass are seen to give rise to the perpendicular hyphae that bear the differentiated well-nourished cells." Sterilization continues until only four or five cells at the base of the perpendicular hyphae remain. "The remaining cells of the perpendicular

hyphae now stand out sharply from the pseudoparenchyma and the undifferentiated cells below them. Their cytoplasm is dense, their nuclei large, and the nucleoles especially large and prominent. They are apparently richly nourished at the expense of the cells of the underlying hyphae and vegetative mycelium. These richly nourished cells form a tissue, two or three cells in depth, that lines the inner basal surface of the young aecidium cup and extends for some distance upward on its lateral surface. . . . Practically all of the cells of this cup-shaped tissue may later fuse in pairs. . . . These gametes of the aecidium cups of *P. Claytoniata* are quite comparable to the gametes of the caeomas. The aecidium of the caeomas is broad and shallow, and the gametes are produced in a single continuous layer beneath the leaf epidermis from which they are separated by a single layer of sterile cells only. They are the penultimate cells of the gametophoric hyphae. The aecidium of *P. Claytoniata* is spherical in shape and is deep-seated in the tissue of the host. The gametes form a tissue, three or four cell layers in depth, that lines the basal surface of the spherical mass. Above the gametes is found a tissue of sterile cells that has resulted from the disintegration of the upper two-thirds of the gametophoric hyphae. In the cup both the gametes and sterile cells form a tissue, while in the caeoma they form but a single layer. The sterile cells of the pseudoparenchyma and the 'buffer' cells of the caeoma seem to be of similar origin and bear the same relation to the respective gametes above which they are borne. In both cases they are possibly gametes which have become sterile."

The conditions found in the development of the aecidia of the other species up to the stage of fertilization are very similar to those described for *P. Claytoniata.* "Excepting minor differences, such as involve the form and size of the cup, its position in the leaf tissue, the relative extent of the pseudoparenchyma, and the number and position of the gametes, the general morphological development of all is of the same nature." The most noticeable difference is in the position of the gametes.

P. Violae is most like *P. Claytoniata,* but the sterile cells do not disintegrate so completely, and consequently form a more compact pseudoparenchyma.

The aecidium of *U. Caladii* is much broader and shallower, and when young has the appearance of a deep-seated caeoma. The perpendicular gametophoric hyphae do not converge towards a central point in the young hyphal mass to such a noticeable degree, but run almost vertically towards the epidermis. The gametophoric hyphae consist of about six or seven cells, the upper three or four of which are sterilized and

the remainder are the gametes. As a rule about two layers of gametes are formed. The sterile cells do not disintegrate very completely prior to the fusions, and consequently scarcely any pseudoparenchyma appears. Both the cells and the nuclei are large and the aecidia favourable for study.

P. augustata, *P. Hydrocotyles*, and *P. Eatoniae* are less favourable for study. The cells of the young aecidia form a more compact hyphal mass, in which the direction of the individual hyphae is more difficult to trace. The pseudoparenchymatous tissue is extensive and reaches to the lateral surfaces of the young aecidia and to a deep point at their basal surfaces. "The gametes of these forms are not so sharply differentiated from the cells of the pseudoparenchyma and the underlying vegetative tissue, and often cannot be distinguished with certainty except when found fusing." Fusion stages were not observed in *P. angustata*, as the material was rather old. The location of the two-legged basal cells seems to indicate that they lie at the very bases of the perpendicular gametophoric hyphae. In *P. Eatoniae* the perpendicular hyphae are completely sterilized, and the gametes are found in the upper two or three layers of the horizontal hyphae that line the basal surface of the hyphal mass. This is similar to what Hoffman (1911) found in *Endophyllum Sempervivi*, where the gametes are also formed in the horizontal hyphae near the base of the cup. *P. Hydrocotyles* is more like *P. Claytoniata;* about five or six cells are found in the perpendicular hyphae below the pseudoparenchyma, and apparently any of the cells of this tissue may function as gametes.

"The fertilization in all these forms is accomplished by the fusion of two closely associated gametes that are normally equal in size and position. The first fusions are found in the central part of the gametic tissue, and the wave of fusions proceeds from this center toward the lateral borders of the aecidium. The fusions are quite abundant, and, though not so readily distinguishable as in the caeomas, many may be found in a favorable section. The process of fusion is identical with that found in the caeomas, and involves the dissolution of an area of the adjoining cell walls between two gametes. The gametes before the fusions are more or less differentiable by their size, the size of their nuclei, and the density of the cytoplasm. The nucleoles are especially large and conspicuous. The dissolution of the walls may take place anywhere in the region of contact between the gametes. They usually lie in parallel hyphae with their lateral walls in contact, and when they are in this position and are of equal height, the initial point of dissolution is usually near the middle of the cells, or slightly above." As a rule, the dissolution of the

walls continues on all sides of this pore until practically all of the adjoining walls have been dissolved away. When gametic fusion is completed the fusion cell elongates and the nuclei move up into the central part of the cell. In *P. Eatoniae* the elongated part of the fusion cell often turns up at a sharp angle. The cytoplasm is more dense in the upper and central parts and often vacuolate at the base. In the early stages of conjugate division the two spindles stand out clearly, lying parallel to each other in the long axis of the fusion cell. "The process of mitosis was not studied in detail, but it seems evident, from the examination of a number of stages in both gametophytic and sporophytic cells, that the essential features are as described by Olive (1908). The spindle figures in the early stages are very small. No central bodies could be differentiated at the poles and radiations were only rarely seen." With the completion of the conjugate nuclear division the fusion cell divides and the apical one-third, containing two daughter nuclei from separate spindles is cut off. This aecidiospore mother cell, or aecidiospore initial, redivides soon afterwards, producing the aecidiospore and the small intercalary cell. The basal cell meanwhile elongates and repeats the process of nuclear cell division. Besides normal cell fusions triple cell fusions were observed in *P. Claytoniata* and *P. Violae*, and trinucleate aecidiospores were frequently found in both of these species and in *U. Caladii*. The gametes may come from the same or separate hyphae. Several quadrinucleate aecidiospores and a chain of quadrinucleate cells were found in *P. Claytoniata*. Spore production follows very rapidly after the fusions. The first fusions are formed at the centre of the gametic tissue and subsequent ones are formed on all sides of this centre in centrifugal order until the lateral borders of the aecidium are reached—the wave of spore production follows closely after the fusion wave. Peridial walls make their appearance with the enlargement of the spore mass. The first peridial cells are seen at the apex of the dome-shaped mass and are produced by a metamorphosis of the apical aecidiospores of the central chains that involves an enlargement of the aecidiospore in all dimensions, a decrease in the density of its cytoplasm, and a marked thickening of its walls. Not all of the interior spore chains produce peridial cells. The lateral walls are made up of the entire peripheral spore chains, and the cells are distinguishable as peridial cells when they have become the third or fourth from the base of the chain. "The cells that make up the lateral walls of the peridium are differentiable from those that form the central arch in that they are modified aecidiospore initial cells rather than aecidiospores. They do not, except perhaps in rare cases, produce intercalary cells."

The production of peridial cells proceeds from the central point of the apical surface of the spore mass outward in all directions until a complete layer is formed over the entire apical and lateral surfaces of the spore mass, usually one cell in thickness. The cytoplasm of the mature peridial cell is vacuolate and the nuclei are smaller and more compact than those of the aecidiospore. "It is difficult to be sure whether they have decreased in size with the metamorphosis of the cell or whether they have not been completely reconstructed from the preceding mitosis." The latter explanation seems the more probable; the nuclei in size and general appearance resemble the nuclei of intercalary cells and do not become disorganized, and the process of wall-thickening accompanies decrease in the density of the cytoplasm, and the natural assumption is that the thickening is produced by the deposition of substances from the cytoplasm. "It seems that in general the shape of the cup and the breadth of the hymenium determine the relative numbers of peridial cells of peripheral and interior origin. If the cup is shallow and the fertile layer broad, as in *Ur. Caladii*, the number of those of interior origin will be comparatively greater than when the cup is deep-seated and spherical and the fertile layer narrow, as in *P. Hydrocotyles*."

Wolf* recorded very deep-seated aecidia in *P. angustata*, which being unable to reach the epidermis discharged their spores into the parenchyma or pith cavity. Fromme did not encounter these. He found, however, in *P. Claytoniata* spermogonia, buried at considerable depths in the parenchyma of the stem, but normal in other respects. The spermatia had been discharged in some cases. "Still more curious were several cases of intimate association between spermogonia and aecidia, in which the spermogonium was borne in the center of an aecidium. None of the aecidia in these cases had reached the stage of sporulation, but the spermogonia had produced spermatia in abundance. The condition is evidently abnormal," and all that it shows is "the similar and perhaps interchangeable nature of the mycelia that produce the two fructifications."

From the work of Moreau and Fromme it seems as if the concept of a "trichogyne" in the Uredineae would have to be abandoned: although probably a septate trichogyne will be suggested to overcome certain difficulties.

Kurssanow (1914) has studied the development of the peridium. Most authors have paid little attention to this and there is much uncertainty as to whether the peridial cells are homologous with the aecidiospores or the aecidiospore spore-mother-cells. This author has investigated several species.

* Mycologia V., p. 303 (1913).

In *Puccinia graminis* the cells which are to give rise to the peridium are formed in a row above a binucleate basal cell in a manner analogous to that of aecidiospore formation. By the time the cell has become the second or third cell of the series it divides into two binucleate cells, a larger one to the inside and a smaller one at its lower end. "Wir haben hier einen Vorgang, der vollständig derjenigen Teilung der Mutterzellen in Aecidiosporen und Interkalarzelle entspricht, welche in den inneren Sporenketten desselben Aecidiums beobachtet wird." The larger cell grows, thickens its wall in characteristic fashion, and finally becomes empty—it is the typical peridial cell. By the growth of the larger cells and by their own growth the smaller cells join up together so that a second layer of binucleate cells is formed which separates the peridium from the tissues of the host plant. The contents of these cells gradually degenerate and their walls become mucilaginous.

The aecidia of *P. Grossulariae, P. Phragmitis, P. longissima, P. Pruni-spinosae,* and *Uromyces Poae* (or *U. dactylidis*) were examined; also *Aecidium ranunculacearum.* "Bei keiner von den genannten Formen fehlte die Bildung von Interkalarzellen, und zwar geschah sie immer in der unteren äussern Ecke der Mutterzelle." There were certain quantitative differences; *e.g.*, *P. graminis* shows a strong growth of intercalary cells, and in *P. longissima* they are very much smaller. Even in cases of abnormal development the intercalary cells are present. Among normal examples of *Aecidium punctatum* was found a form which could not be distinguished externally but which was a truly uninucleate form.* The basal cells, aecidiospores and intercalary cells, peridial cells, and their intercalary cells were all uninucleate.

Endophyllum Sempervivi also shows a development of intercalary cells, but in this case the division of the peridial-mother-cell is more or less longitudinal, so that from the commencement there is a row of intercalary cells. In some cases there appeared to be no intercalary cells, and this is probably due to the fact that the basal cell of the peridium is not always the outermost cell of the hymenium in this species.

In *Gymnosporangium tremelloides* the peridium-mother-cells are very large and the intercalary cells develop as in *P. graminis.*

In *Peridermium Pini* a double layer of peridial cells has often been recorded. Kurssanow finds that the peridium is developed as in the other forms studied. In some cases, however, the intercalary cell, instead of becoming mucilaginous,

* *Cf.* Aecidium on Euphorbia silvatica (Moreau). Trans. Brit. Mycol. Soc. III., p. 363 (1912).

develops a hard thick wall similar to that of a peridial cell. The author has investigated many genera and families of Uredineae, and believes that the process described is constant, and that the intercalary cells and their ultimate fate have a physiological significance: "sie befördern das Durchwachsen des Aecidiums durch das sterile Hyphengeflecht." When a large amount of tissue must be broken through *(Gymnosporangium)*, or dense tissue *(P. graminis)*, a well-marked development of these cells is observed.

The development of the peridial cells at the apex of the aecidium corresponds to the account given by Richards, Dittschlag, and Fromme (above). Kurssanow investigated it in *P. graminis*, *P. Caricis*, *P. phlomitis* and *P. Pruni-spinosae*. "Überall wurde beobachtet, dass die den Peridiumdeckel bildenden Zellen, ebenso wie die anderen Zellen der Sporenkette, nach unten Zwischenzellen absondern. Also kann man als allgemeine Regel für echte Aecidien aufstellen, dass ihr Deckel ebenso wie die Seitenwände, aus den Zellen, die den Aecidiosporen homolog sind, zusammengesetzt ist."

The development of *Peridermium Pini* is described in greater detail. The spore-forming layer is formed under the hypoderm of the pine needle as a broad but not dense uninucleate tissue. At a depth of two or three cells fertile cells were differentiated. Their upper walls become much swollen, and finally flow together, forming an irregular membrane which shows signs of becoming mucilaginous. From the centre outwards begins a fusion of the gametes in pairs, as described by Christman (1905). The fusion cell forms the basal cell of the spore chain. Usually after only two cells are formed the upper one begins to differentiate into a peridial-mother-cell. It divides into two unequal binucleate cells, of which the lower one is the larger, and, thickening its wall, becomes a peridial cell. The smaller cell becomes pressed into the overlying membrane and there becomes mucilaginous. This case is the reverse of that described above; not the aecidiospore but the intercalary cell is here the homologue of the peridial cell. The matter is probably of little morphological importance, as the two cells are sister cells.

BASIDIOMYCETES.

Wager (1914) has studied the development of the basidia in *Tremella* and *Dacryomyces*. The basidium of *Tremella* is spherical and becomes filled with dense protoplasm. When very young it contains two nuclei, which later fuse to form the basidium nucleus, which increases in size and becomes very prominent in the later stages. This nucleus divides transversely and a wall then appears between the two daughter

nuclei dividing the basidium longitudinally into two cells. The nuclei undergo a further division, with accompanying cell division, so that the basidium is divided into four cells. From the apex of each cell a sterigma is produced, the apex of which swells up to form a spore, into which the nucleus passes. In the first division of the nucleus eight chromosomes are found, which separate into two groups of four. In the second division only four chromosomes appear, and these divide by fission into two groups of four. "The somatic nuclei of the Fungus also contain only four chromosomes each." *T. Genistae* and *T. lutescens* were studied by Istvánffi (1895).

Dangeard (1895) gave an interesting account of the cytology of *T. mesenterica*, but did not succeed in obtaining the division stages of the basidial nucleus.

In *Dacryomyces*, the basidium is an elongate cell containing dense protoplasm. "At a very early stage two minute deeply stainable bodies are to be observed. These are probably nuclei." At a later stage a single large nucleus is clearly seen, which by subsequent divisions gives rise to four nuclei. At the apex of the basidium two sterigmata are formed, each of which produces a spore. "One nucleus at least passes into each spore. The fate of the other two nuclei has not been ascertained. . . . it is not impossible that the four nuclei may pass in pairs into the two spores." The basidium nucleus shows eight chromosomes during the first division, and four chromosomes appear in the subsequent divisions and in the somatic nuclei. The species *Dacryomyces deliquescens* has been studied by Istvánffi (1895), Dangeard (1895), Juel (1898) and Maire (1902).*

Fitzpatrick (1914) has investigated the parasitism, biology and cytology of the fungus named *Eocronartium typhuloides* by Atkinson. The latter stated that the plant might very easily be mistaken for *Typhula muscicola*. The basidia are curved, transversely septate and formed on the outside of the long, slender, erect fruit body. The genus *Eocronartium* was proposed for its reception. "This name does not imply that this plant is the direct progenitor of *Cronartium* of the Uredineae, but its form, habitat and fructification forcibly suggest that it represents a type of the lower Basidiomycetes closely related phylogenetically with *Cronartium*. This suggestion is even more striking when we know that the long, slender, columnar fruit body of *Cronartium* forms the curved, transversely septate promycelia, bearing the sporidia, as soon as mature; and the question may well be asked if the Uredineae do not represent a group of later development than the Auriculariaceae, and greatly specialized through a long period of

* *Cf.* Trans. Brit. Mycol. Soc. IV., p. 162 (1913).

parasitism." Fitzpatrick has examined type material of *Typhula muscicola* Fr. and *Clavaria muscigena* Karst. Both proved to be *Eocronartium*, and the fungus must therefore be known as *E. muscicola.** The fungus has been demonstrated to have a high degree of parasitism. The mycelium is intracellular and hibernates in the moss stem. Practically no injury to the host results, although almost all its cells, including those of the growing point, are infested. Infection experiments have given positive results, and the study of longitudinal sections of the moss stem show the fungus to be perennial and prove that the external *Typhula*-like fruit body arises from the parasitic mycelium. "The spores germinate in the uninucleate condition and the binucleate cells arise in the germ tube. Fusion and reduction takes place in the young basidium; the mature basidium being transversely septate into four cells, its homology to the promycelium being evident." The author's full account will be awaited with interest as well as the conclusions he is able to draw as to the relation of this form to other groups with transversely septate basidia.

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* The present writer has examined specimens of *Typhula muscicola* Fr. from various sources and found a transversely septate basidium, whereas other species examined (e.g. *T. erythropus*) show a basidium of the more usual, non-septate type. It is hoped to make a study of the British species of the genera *Typhula* and *Pistillaria*.—J.R.

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SOME NEW BRITISH HYMENOMYCETES.

By E. M. Wakefield, F.L.S.

In the course of work on the Thelephoraceae during the past four seasons, a number of additions to the British list have come to light. Some of these have already been recorded; a further list is here given, with some descriptive and critical notes. It seems probable that in course of time most of the species which are known on the Continent will be found to occur in Britain also, but in the resupinate genera, in which distinctive macroscopic characters are so few, it is only by the careful examination of as much material as can be obtained that any idea will be gained of the richness of our flora.

The references to colours are from Ridgway's "Color Standards and Color Nomenclature," 1912.

Sebacina calcea Bres. Fung. Trid. II., p. 64, tab. CLXXV. *Corticium calceum* Fr. Hym. Eur. p. 652, pp. *Thelephora calcea* Pers. Syn. p. 581.

Very thin and closely adnate to the bark, chalk-white, or with a tinge of grey or brown when old. Hymenium finely cracked when dry. Basidia at first globose, then more elongated and longitudinally cruciately septate, 18-25 × 12-16μ; sterigmata up to 30μ long, 3-4μ wide. Spores reniform, curved, 15-16 × 7-8μ.

On dead branches, near Buxted, Sussex, A. D. Cotton, April, 1912.

SEBACINA (BOURDOTIA) EYREI Wakefield, sp. nov.

This species was first sent me in May, 1914, by the late Rev. W. L. W. Eyre, who found it on a decorticated beech log lying amongst bushes in his garden. In October, 1914, a second specimen was sent from Mulgrave Woods by Miss C. A. Cooper. I have been unable to identify it with any known species, and therefore describe it as new.

Late indeterminato-effusa, tenuissima, circa 40-45μ crassa, subhyalino-grisea, in sicco albido-grisea, arcte adnata. Hymenium laeve vel hinc inde tuberculata. Basidia primo obovata, continua, demum longitudinaliter cruciatim 4-partita, 4-sterigmatica, 10-13 × 7-8μ; sterigmata curvata, 7-9μ longa,

1·5μ diam. (ad basim). Sporae globosae, hyalinae, 4-6μ diam. Gloeocystidia creberrima, e basi oriunda, non vel vix emergentia, cylindracea vel subfusiformia, succo luteo-olivaceo, granuloso repleta, 25-35 × 5-7μ. Hyphae contextus hyalinae, indistinctae, adglutinatae.

Hab. ad lignum fagineum, Alresford, Hampshire; ad lignum putre, Mulgrave Woods, Yorkshire.

This species is well characterised by the globose spores and the presence of gloeocystidia. The basidia are extremely difficult to see except in perfectly fresh, vigorous specimens; they appear to remain for a long time unseptate, but the mature basidia are distinctly septate, although the apex of the basidium is abruptly flattened, and the divisions do not merge gradually into the sterigmata, as in most basidia of this type. The tissue of the sporophore is exceedingly thin, and shows no clear differentiation of hymenial and subhymenial tissue. The vegetative hyphae penetrate deeply into the wood, and are of two types, namely, thin hyaline hyphae, and larger, thicker-walled, red-brown hyphae. The latter run longitudinally in the vessels, and pass from one to another through the walls. They are 3-6μ in diameter, and frequently septate, sometimes almost moniliform. When present in quantity these coloured hyphae stain the wood a bright orange-red, as is the case in the original specimen. In the Mulgrave specimen, however, this colour is not nearly so marked, traces only being present.

Hypochnella violacea (Awd.) Schroet. Die Pilze Schlesiens, I., 1888, p. 420.

Irregularly effused, very thin, when fresh of a rich lilac colour (Ridgway 69″″d to 69″″i), becoming darker and duller when dry, and then scarcely distinguishable from the bark. Hymenium of the loose "Hypochnus" type, consisting of basidia intermixed with paraphyses. Basidia hyaline or faintly coloured, cylindric-clavate, 8-9μ wide above, 20-25μ long. Paraphyses shorter, obtuse, 10-12 × 6-7μ, frequently with a few crystals on the external walls. Spores deep violet, smooth, elliptical, with a lateral basal apiculus, 7-9 × 3-4μ. Subhymenial hyphae very faintly coloured, often slightly encrusted with small rounded crystals; basal hyphae pale lilac, 6-9μ in diameter, with no clamp-connections.

On the under side of fallen branches, Edlington Woods, Doncaster, September, 1914.

This interesting fungus was collected by several members of the Society during the autumn foray at Doncaster. There seems to be very little doubt that this is the species described by Schroeter. Schroeter founded the genus *Hypochnella* to include the one species *H. violacea*, differing from other

genera of his family Hypochnacei in possessing *smooth, violet* spores. Since his time the plant does not appear to have been collected again, and unfortunately his type, from Baden, is not in existence. Von Höhnel, who has examined the specimens in Schroeter's Herbarium, and also in the Herbarium at Berlin, states that he was unable to find the Baden type, and that the only specimens included under this name were sterile. In one of the Berlin specimens he found spores, which agree well with those of the present plant, but saw no basidia nor cystidia, and could not be certain that the spores belonged to the mycelium present. The British specimens agree with Schroeter's description in colour, habit, and also in the microscopic details, with the exception that Schroeter recorded the presence of cystidia, projecting beyond the basidia. No projecting bodies could be found in these specimens, but from the description ("walzenförmigen, 5-6μ breiten, an den Enden abgerundeten, mit stumpfen Warzen besetzten Borsten"), it appears probable that these were merely more elongated paraphyses similar to those described above, which might be expected to vary in development. The "Warzen" in all probability were the crystals, which Schroeter also mentioned as occurring on the hyphae.

Corticium vellereum Ellis and Cragin, in Bull. Washburn Coll. Lab. Nat. Hist. p. 65. (Copied in Journ. of Mycol. I., 1885, p. 58.) *Corticium chlamydosporium* Burt, in Peck's 54th Report, 1901, p. 154 (nomen). *C. Bresadolae* Bourdot, Rev. sc. Bourb. 1910, p. 6. (fide Bourdot in litt.).

Effused in large, more or less rounded patches, rather thick and waxy. Hymenium when fresh smooth, waxy white, cream, or tinged buff-pink, margin of pure white, silky, radiating hyphae. The hymenium retains its colour on drying, and remains perfectly smooth, uncracked, and pulverulent with the spores. Basidia very long, 6-7·5μ wide above, gradually tapering downwards into the subhymenial hyphae, the mature basidia projecting above the general surface of the hymenium up to 30μ; sterigmata 2-4, curved, 4μ long. Spores subglobose, or broadly elliptical, 5-9 × 5-7·5μ, apiculate at the base. Basal hyphae very loosely interwoven, sparingly branched, with clamp-connections at the septa, 2-6μ in diameter.

On bark, Winchester, F. Escombe, December 1911, and January 1912.

In the British specimens, and in American specimens named by Burt which I have examined, the basal tissue contains abundant oval or pyriform chlamydospores, 9-10 × 6-8μ. In a Canadian specimen sent me by Professor Buller, however, these bodies are not present, nor, according to the description of

C. Bresadolae, are they always present in the French specimens, so that this character is not invariable. It would appear from Bourdot's notes that the conidial, or chlamydosporous condition is formed in great shade, and may or may not subsequently become covered with the normal hymenium. Unfortunately I have had no opportunity of investigating the conditions of growth with the living plant.

The species was submitted to Professor Burt as his *C. chlamydosporium*, and I am indebted to him for the information that *C. vellereum* is an earlier name for the same species.

Corticium echinosporum Ellis, in Bull. Torr. Bot. Club, 1881, p. 64. *Hypochnus mollis* Fr., var. *pellicula* Fr. Elench. I, p. 216. *Hypochnus pellicula* Bres. in Ann. Myc. I, 1903, p. 107. *Tomentella pellicula* v. Höhn. et Litsch. in Sitzungsber. der k. Akad. d. Wissensch., Wien, Math.-Nat. Kl., Bd. CXVI., 1907, p. 786.

Indefinitely effused, very delicate, thin, and soft. Mature hymenium, as seen under the lens, forming a fine pulverulent pellicle over the thin, white, cobwebby, basal tissue, either sulphur yellow or more or less dull rose-pink in colour. Margin very thin and indefinite, whitish, with occasionally very fine, white hyphal strands spreading from it over the subiculum.

In section, tissue very loose, and easily separated from the substratum. Basidia cylindrical to clavate, 20-30 × 6-8μ; sterigmata 2-4, slightly curved, 3-5·5 × 1-1·5μ. Spores very finely, closely, and evenly aculeate, with very short prominences which are little more than minute warts, hyaline or pale straw-coloured, the contents sometimes coloured golden-yellow or rosy, subglobose or in lateral view broadly elliptical, 5-7μ diameter, or 5-7·5 × 4-6μ. Basal hyphae hyaline, or very faintly coloured, branched, septate, without clamp-connections, 2·5-5μ in diameter.

On the under side of very rotten wood lying on the ground. Clyne Woods, near Swansea, E.M.W., October 1914, (yellow form); Earlswood, Warwickshire, W. B. Grove, No. 5, October 1913, (pink form).

There are two distinct colour forms of this species, and the above description is compiled from both. In the type form of *C. echinosporum* the hymenium is pale, clear, sulphur-yellow (Ridgway, "sulphur yellow," 25f, or "naphthalene yellow," 23' f), and when old here and there spotted with brown. In the other form the mature hymenium is dull rose-pink, occasionally with a very faint lilac tinge, and with darker reddish or brownish stains. This form is that given out under the name *Hypochnus pellicula* Bres., in the Kew and British

Museum examples of Brinkmann's Westf. Pilze, No. 69, and as *H. pellicula* forma *rosea* Bres., in Krieger. Fung. Sax. No. 1805. The spores of the form *rosea* are usually pale straw-coloured in the mass, and average very slightly larger than those of the type, which are hyaline, or with yellowish contents only.

Taking into account the sum of the characters, the species appears to me to be more closely allied to the species of *Corticium* with hyaline, rough spores, than to the typical *Tomentellas* with their deeply coloured hyphae, and large, brown, coarsely spiny, or angular spores. The specific name *echinosporum* is adopted in accordance with Art. 49 of the International Rules of Nomenclature.

Corticium (Gloeocystidium) roseo-cremeum Bres. in Ann. Myc. III., 1905, p. 163, and in Brinkmann, Westf. Pilze, No. 56.

Effused, pallid pink, or dull reddish where bruised, soft and waxy, margin pale, indeterminate. Hymenium not cracked when dry, consisting of basidia and paraphyses. Basidia projecting up to 15μ above the general surface of the hymenium, 6-7·5μ wide above, long and tapering gradually below into the basal hyphae; sterigmata 2-4, spreading, rather straight, 5-7 × 1-1·5μ. Paraphyses long, slender, wavy, blunt at the apex, 2-3μ in diameter. Occasional gloeocystidia present, completely sunk in the tissue, cylindrical, wavy, 30-90 × 5-9μ, contents pale yellowish. Spores cylindrical, straight, the inner side flattened, 8-11 × 3-4μ. Basal hyphae hyaline, 3-4μ in diameter, with occasional clamp-connections.

On rotten wood, Mulgrave Woods, Yorkshire, W. N. Cheesman, October, 1912.

Well marked by the colour, the long straight spores, and the wavy paraphyses intermingled with the basidia.

Corticium (Gloeocystidium) praetermissum (Karst.) Bres. in Ann. Myc. I., 1903, p. 100. *Peniophora praetermissa* Karst. Finl. Basidsv. p. 423. *Corticium pertenue* Karst. Hedwigia 29, 1890, p. 270. *Corticium tenue* Pat. Rev. Myc. 1885, p. 152.

Effused, pure white and rather waxy when fresh, margin very thin, indeterminate. Hymenium becoming cream-coloured with age, or on drying. Gloeocystidia cylindrical, subfusiform, or slightly ventricose, with pale yellowish contents, 25-150 × 5-11μ. Basidia 18-38 × 6-11μ; sterigmata 2-4, rather straight, 4·5 × 1μ. Spores elliptical to cylindric-ellipsoid, slightly curved or with one side flattened, 7·5-12 × 3·5-6μ, average 9 × 4·5μ. Basal hyphae loosely interwoven, much branched, 2·5-7μ, with clamp-connections.

On bark and wood of fallen branches, common. Kew Gardens, E. M. W., 1911; Taunton Foray, 1911; Aberdeen, C. O. Farquharson, 1911; Mulgrave Woods, Y.N.U. Forays, 1913, 1914; Haslemere, E. M. W., October, 1913; Doncaster Foray, 1914; North Stoneham, Southampton, on oak, J. F. Rayner, September, 1914.

In the typical form the gloeocystidia are mostly sunk in the tissue; in the form called *C. tenue*, however, they usually project above the hymenium, and in this case the contents appear to be excreted, since the body of the cystidium usually appears empty, while it is capped with a cluster of crystal-like bodies which are soluble in dilute potassium hydrate, similar apparently to those figured by Massee in the cystidia of Inocybe.

Peniophora cremea Bres. Fung. Trid. II., p. 63, tab. CLXXIII., f. 2.

Broadly effused, separable, hymenium white, cream, to ochraceous, membranous to waxy, becoming looser towards the margin, which is white and cobwebby, not at all fibrillose. Hymenium cracked when dry, showing the white subiculum, under the lens often glistening from the abundant cystidia. Cystidia smooth, or slightly encrusted at the apex with easily detached crystals, arising from the subhymenial hyphae, and usually projecting above the hymenium up to 60μ, cylindrical or slightly elongated fusiform, tapering very gradually from the base to the blunt apex, 70-120 × 5-9μ, walls very thin. Sometimes thicker-walled, embedded cystidia are present, shorter than the projecting ones, fusiform, much encrusted, 40-60 × 9-10μ. Mature basidia 7μ wide above, tapering below, 20-50μ or sometimes more in length, intermixed with young basidia, the whole forming a compact hymenium. Spores cylindric-ellipsoid, slightly curved, 4-8 × 2-4μ. Subhymenial hyphae loosely interwoven, much branched and rather rigid, thick-walled, constricted at the septa so as to appear somewhat jointed, with no clamp-connections, 5-6μ in diameter.

On bark, fairly common. Kew Gardens, E. M. W., 1912; Riccall, near Selby, W. N. Cheesman, 1912; Dolgelly Foray, 1913; Mulgrave Woods, Yorkshire, Y.N.U. Foray, 1914; Forest of Dean, 1914; Monk Wood, near Worcester, C. Rea, 1914; Doncaster Foray, 1914.

Very closely allied to *P. velutina*. It differs in never turning red in the herbarium, in the character of the basal hyphae, which in *P. velutina* are thin-walled and lax, and in the smoother cystidia. I have examined a large number of specimens, and feel that it is not practicable to maintain *P. Allescheri* Bres. as a distinct species. The type forms of *P. Allescheri* and *P. cremea* represent two extremes, the latter

being a very thin plant with no thick-walled embedded cystidia, while *P. Allescheri* is thicker, with the basal tissue more sharply differentiated from the hymenium, and containing numerous short, rough, thick-walled cystidia, as described above. Intermediates, however, occur. Of the above specimens, those from Doncaster and Mulgrave are of the typical *Allescheri* form, while the Forest of Dean collection is intermediate, having the thicker, sharply differentiated basal tissue, but no embedded cystidia.

Peniophora Molleriana (Bres.) Sacc. Flor. Mycol. Lusit., p. 7.
P. Roumeguerii Bres. Fung. Trid., p. 36, tab. CXLIV., f. 1.

Broadly effused, closely adnate to the substratum, rather thick and hard, brittle when dry, cream to bright biscuit-coloured, margin white, abrupt; hymenium cracked when dry. Cystidia very abundant, fusiform to conical, thick-walled, much encrusted in the upper portion, apex acute, 60-70 × 10μ. Most of the cystidia are embedded in the tissue, and in old specimens several layers may be present, indicating several seasons' growth. Basidia small, clavate, 4-5μ wide, with 2-4 straight sterigmata, 2-4μ long, ·5μ thick. Spores elliptical, 3-5·5 × 2-2·5μ. Hyphae closely adglutinate, scarcely distinguishable, 2-2·5μ in diameter.

On fallen log, Great Doward, Symond's Yat, N. G. Hadden, May, 1914.

Resembling *P. gigantea* in the abundant, acute, and strongly encrusted cystidia, but differing in colour and texture. *P. Molleriana* never dries with a smooth horny texture like *P. gigantea*, but has a dry, opaque, almost farinaceous appearance, and is very brittle.

Peniophora Aegerita v. Höhn. et Litsch. in Sitzungsber. der k. Akad. Wissensch. Wien, Math. Nat. Kl., Bd. CXVI., 1907, p. 810.

Effused, thin, white to alutaceous, finely bristly with cystidia when seen under the lens, somewhat resembling thin specimens of *P. setigera*. Cystidia arising from the basal tissue, cylindrical, or slightly swollen below, apex blunt, walls thick and rough throughout their length, 42-80 × 6-10μ. Basidia clavate, 7-8μ wide, with 4 sterigmata, 4-6μ long. Spores broadly elliptical or obovate, 6-9 × 5-6μ. Basal hyphae 3-5μ in diameter, with clamp-connections.

Taunton Foray, 1911; Nunnery Wood, near Worcester, C. Rea, 1912; Penrith, 1913.

This species is always in association with *Aegerita candida*, and von Höhnel and Litschauer state that the latter is a stage of the Peniophora. I have been unable to investigate the

point, as all the specimens received have been very small and in poor condition. The species is well marked by its oval spores and cylindrical, rough-walled cystidia.

Peniophora glebulosa Bres. Fung. Trid. II., p. 61, tab. CLXX., fig. 2.

Effused, cream, dirty white, or greyish, closely adnate, when young very thin and pubescent, later thicker, and when dry cracked into small, irregular areas. Hymenium rough with cystidia. Cystidia smooth or slightly encrusted in the upper portion, cylindrical to conical, apex rounded, arising from the basal tissue and frequently forked below, some sunken and some projecting up to 90μ above the hymenium, 70-120 × 7-12μ; walls rather highly refractive and very thick, so that the lumen of the cystidium is very narrow or almost obliterated, except at the apex, where the wall is thin and the lumen expands suddenly. Basidia 5-15 × 3-4μ, with 4 sterigmata about 4μ long. Spores narrowly cylindrical, curved, 7-9·5 × 1·5-2μ. Hyphae 1-2·5μ in diameter, very closely interwoven and scarcely distinguishable.

On wood and bark, not uncommon. New Forest, on Spruce, G. Massee, 1912; Mulgrave Woods, Yorkshire, 1912, 1913; Haslemere, E. M. W., October, 1913; Forest of Dean, May, 1914.

First recorded in "The Naturalist" for May, 1914.

The thick lateral walls of the cystidia are dissolved by potassium hydrate solutions, so that in sections so treated no cystidia can be seen. In lactic acid preparations they retain their characters.

Peniophora subalutacea (Karst.) v. Höhn. et Litsch. in Sitzungeber d. k. Akad. Wissensch. Wien, Math.-Nat. Kl., Bd. CXV., 1906, p. 601. *Kneiffia subalutacea* Bres., Ann. Myc. I., 1903, p. 104. *Corticium subalutaceum* Karst. Symb. Myc. Fenn. X., p. 65.

Effused, dirty white or greyish, with a slight ochraceous tinge. Hymenium loose, and rather rough under a lens, with slight, irregularly scattered thickenings of the tissue (hardly granules). Cystidia smooth, evenly cylindrical, 95-150 × 5-7μ, projecting beyond the hymenial surface 60μ or more, walls thin, more so at the rounded apex. Basidia 4-5μ wide, with 2-4 straight sterigmata 5μ long. Spores narrowly cylindrical, slightly curved, 7-9 × 1·5-2μ. Basal hyphae much branched, and wavy, rather rigid, thick walled, 2-3μ in diameter, with clamp-connections.

On wood, Edlington Woods, near Doncaster, September, 1914.

Closely allied to *P. subcremea*, v. Höhn et Litsch., from which it differs in the longer spores and larger cystidia. It is also near to *P. glebulosa*, but is easily distinguished by the cylindrical, thin-walled cystidia.

Peniophora pallidula Bres. in Bourd. & Galz., Bull. Soc. Myc. Fr. 1912, p. 390.

A description of this species has been published in "The Naturalist," March, 1915, p. 99. Alresford, Rev. W. L. W. Eyre, 1914, on Fir; Mulgrave Woods, Y.N.U. Forays, 1913, 1914.

Grandinia helvetica Fr. Hym. Eur. p. 627

Effused, thin, separable, pale yellowish to deep ochraceous when fresh, drying alutaceous or sometimes with a faint greyish tinge. Hymenium, when fresh and well-developed, soft, made up of closely crowded, small, irregular tubercles. On drying, the hymenium shrinks, cracking into small irregular patches, and showing in the interstices a network of fine, silky fibrils. These mycelial strands are very evident in specimens in which the hymenium is poorly developed, and sometimes radiate one to two inches beyond the margin. Basidia cylindrical to clavate, 20-35 × 6-9μ; sterigmata 4, slightly curved, 3-7 × 1μ. Spores smooth, yellowish, subglobose or obovate, pointed at the base, 3·5-6 × 3-4μ, each with a single oil-drop. Basal hyphae yellowish, 4-8μ in diameter, with occasional clamp-connections, often united to form long branching strands.

On fallen branches, not uncommon. Kew Gardens, E.M.W., 1911-13; Selby, W. N. Cheesman, 1911; Weybridge, E.M.W., 1912.

NEW BRITISH FUNGI.

By John W. Ellis, M.B., F.E.S.

HENDERSONIA JUNCINA. *n.s.*

Peritheciis minutis (1/10 mm. diam.), gregariis, subcuticularibus, sphæricis, flocculosis, nigris. Sporulis cylindricis vel fusiformibus, utrinque angustatis, apicibus obtusis, tri-septatis, 14-18 × 3·5-4μ, pallidissime ochraceis.

In culmis putridis *Junci effusi* Burton (Ches.), February, 1914.

Not visible without the aid of a lens but causing a slight unevenness of the surface. The colour of the spores is faint but distinct and the spores are relatively more slender than those of a Stagonospora on the same host.

Stagonospora Luzulæ (West.) Sacc. = *Hendersonia Luzulæ*, West. Bull. Ac. Belg. II. Ser. t. XIX., n. 7; Mich. I., p. 210; Syll. III., No. 2466.

Perithecia minute (1/8 mm. diam.), gregarious, black, arranged somewhat in rows, immersed in the substance of the leaf and opening through a minute pore, the surrounding epidermis becoming slightly blackened; sporules cylindrical, straight, rounded at both ends, with 4 nuclei (afterwards 1- or 2-septate), 11-14μ × 2·5-3μ, hyaline.

On withered leaves of *Luzula pilosa*, Eastham Wood (Cheshire), March 21, 1914.

Recorded by Saccardo on this host plant and on *Luzula maxima* in Northern Italy, France, and Belgium.

[Leaves of *Luzula pilosa* attacked by what I believe to be this same species, were met with on the Gloucestershire bank of the Wye at Symonds Yat during the spring foray, 1914. They differ only in having the spores distinctly pale yellow in colour and in being triseptate. Probably the fungus is more correctly referred to Hendersonia than to Stagonospora.]

Stagonospora innumerosa (Desm.) Sacc. = *Hendersonia innumerosa* Desm., 19 Not. p. 10; Saccardo, Sylloge III., No. 2467.

Culmicolous, perithecia very minute (50μ diam.), globular, black, situate beneath the epidermis and tending to be arranged

in rows, opening by a minute pore. Sporules oblong, straight or slightly curved, obtusely rounded at each end, 20-30$\mu \times 7\mu$ (in my specimens 22-28$\mu \times 5{\cdot}5$-7μ) with four large vacuoles and (in some of my specimens) ultimately 3-,4-, or 5-septate, hyaline.

On dead culms of *Juncus effusus* in the parish of Burton-in-Wirral (Cheshire), February 28th, 1914.

The species is recorded by Saccardo from dry culms of *Juncus maritimus* in France.

Camarosporium Ilicis Oudem. Contr. Fl. Myc. Pays-Bas XVI., 74; Hedwigia 1898, p. 179; Sacc. & Sydow, Syll. XVI., p. 952.

Perithecia sparingly distributed, 1/3 mm. diameter, covered by the epidermis, which is blackened and raised in a more or less conical manner and pierced by a minute pore around which is a pallid area; spores elliptical or elongate-elliptical, rounded at both ends, 3 (or frequently 4) septate, and generally with one or two cells longitudinally septate, 14-16 $\times$ 7μ, deep yellow.

On dead twigs of *Ilex Aquifolium*, Eastham Wood (Cheshire), January, 1915.

Previously recorded only from Holland.

Septoria caricicola Sacc., Mich. I., p. 196; Sylloge III., No. 3074.

Perithecia punctiform, covered by the epidermis which is finally pierced, black, scattered or arranged in lines on (chiefly) the upper surface of the leaf; spores elongate-cylindrical, curved or flexuous, obtuse at each end, 7 (rarely 6 or 8) septate, slightly constricted at the septa, 35-55 $\times$ 4μ, very pale yellow.

Saccardo describes the perithecia as seated on pale spots with brown margins, but in my specimens, all on completely withered leaves, no macula is visible, but the species is, I think, sufficiently characterised by the unusual width (in proportion to length) of the spores.

On dead leaves of *Carex riparia*, Meols (Ches.), April, 1914. Hitherto recorded only from Northern Italy.

Septoria Sparganii Passer., Funghi Parm. No. 124; Sacc. Sylloge III., No. 3092.

Perithecia very minute (about 1/20 mm. diam.), arranged somewhat in rows and seated on a somewhat blackened area of the leaf, globular, black, projecting slightly above the level of the cuticle; sporules elongate, nearly linear, straight, curved, or bent at an obtuse angle, bluntly rounded at the ends, pluri-septate (in my specimens invariably 7-septate, with a small nucleus in each cell), 35-45$\mu \times 2{\cdot}5\mu$, very pale transparent yellow.

On dead leaves of *Carex riparia*, at Leasowe (Cheshire), February 7, 1914.

This very distinct species of Septoria is recorded by Saccardo only from Parma, Northern Italy.

Phlyctæna Coryli Lamb et Fautr. Bull. Soc. Myc. de France 1899, p. 155; Sacc. et Sydow Syll. XVI., p. 981.

Perithecia loosely gregarious, covered by the epidermis, flattened-globose, 1/2 mm. diam., with a slight papilla, at length opening by a round pore; sporules (in my specimens) filiform, straight or slightly flexuose, hooked towards one end, 20-28 × ·75-1μ, hyaline.

In twigs of *Corylus Avellana*, Edlington Wood, Doncaster, September 25, 1914.

This species has the spores of a Phlyctæna but the *round* pore of a Rhabdospora, and is possibly the *Rhabdospora notha* Sacc. var. *Coryli* Sacc., although the spores in that variety are described as 30-35μ long. This species is considered by Saccardo a doubtful Rhabdospora which has hitherto only occurred in the Ardennes. *Phlyctæna Coryli* has been recorded only from Côte d'Or, France.

Corrigenda.

Two corrections have to be made in my notes on New British Fungi in Trans. Brit. Mycol. Soc. v. IV., viz.:—

(p. 126) *Septoria Lunariæ n.s.*

While certainly new to Britain, it has been pointed out to me by W. B. Grove that apparently this species was described by "the other Ellis (U.S.A.)" in Canad. Rec. Sci. Jan. 1893, p. 269, under the name of *Septoria lunariæ* Ellis and Dearn. A singular coincidence!

(p. 295) *Gloeosporium Loniceræ n.s.*

I regret that an insufficient understanding of the characters of this genus has led me to record, chiefly on account of the Gloeosporium-like character of the spores, under the above heading, a well-known Sphaeropsid, *Leptothyrium Periclymeni* Desm. I am indebted to W. B. Grove for pointing out this error.

FUNGI IN THE NESTS OF ANTS.

PLATE II.

By Jessie S. Bayliss Elliott, D.Sc. Birm., B.Sc. Lond.

The occurrence of fungi in the nests of ants has been repeatedly observed by Naturalists visiting tropical and subtropical countries, and during the last few years several investigators have given much attention to the subject. Möller* has published the results of extensive researches on the leaf-cutting ants of South America and demonstrated the truth of Belt's statement that "Ants are mushroom growers and eaters";† Tanner, Von Ihering and Wheeler have also written on the subject, and we are indebted to the researches of Petch‡ and others for our knowledge of the Termite fungi of Ceylon and elsewhere.

But it is not generally known to Mycologists that the nests of two species of British ant—*Lasius fuliginosus* and *Lasius umbratus*—also have fungi associated with them.

It is associated with the black earthy, brittle substance known as carton, which these ants use in constructing their nests.

CLADOSPORIUM MYRMECOPHILUM (Fres.) nov. comb.

The fungus in the nest of *Lasius fuliginosus*, which occurs as a pure culture, was described in 1852 by Fresenius§ and named *Septosporium myrmecophilum.*

Saccardo‖ describes it as *Macrosporium myrmecophilum*, but considers it may be identical with *Cladotrichum microsporum.*

Later, 1900, Lagerheim¶ investigated it and came to the conclusion that it was really a *Cladotrichum*, and called it *Cladotrichum myrmecophilum.*

* Möller, Die Pilzgärten einiger Südamerikanischer Ameisen. Schimper. Botanische Mittheilungen aus den Tropen. Heft VI., Jena 1893.

† Belt, Naturalist in Nicaragua, page 79.

‡ Petch, Annals of the Royal Botanic Gardens, Peradeniya, 1906 and 1913. Science Progress, October, 1907.

§ Fresenius, Beiträge zur Mykologie. Heft 2, page 49, t. VI.

‖ Saccardo, Sylloge Fungorum. Vol. IV.: Hyphomycetes, page 538.

¶ Lagerheim, Ueber *Lasius fuliginosus* und seine Pilz-zucht. Entomologisk Tidskrift, 1900, page 17.

This uncertainty as to genus arises from the fact that the conidia had never been found attached to the conidiophores.

Through the kindness of Mr. H. Donisthorpe, a well-known authority on ants, I obtained a supply of carton taken freshly from a nest. After examining portions of it teased out in water (fig. 1) I felt inclined to think that Fresenius had rightly assigned it to the genus *Septosporium*.

Two kinds of dark-coloured hyphae were to be seen, creeping hyphae (fig. 1a) whose septa lay very close together, the cells often being inflated, thus giving the hyphae a nodulose appearance; and arising from the creeping hyphae numerous long erect hyphae (fig. 1b), generally simple, but sometimes branched (fig. 1e); it was conspicuous that many of these erect hyphae were truncate (fig. 1b).

Conidia were not abundant, no doubt because consumed by the ants: they were dark coloured, oval, 10-14μ × 4-6μ, and mostly uniseptate, though unicellular ones were often seen (fig. 1c & d); a few 3-celled and 4-celled forms were found, and also four examples of a triangular form of three-celled conidium (fig. 4).

Like Fresenius and Lagerheim I could not find any of the conidia attached to the conidiophores except a few of the unicellular forms, which were apparently sessile on the nodulose creeping hyphae (fig. 1f).

However, after making hanging-drop cultures of the fungus and allowing them to grow for a few weeks, uniseptate conidia attached to conidiophores appeared (fig. 2).

It was now evident that the erect hyphae which Fresenius had considered sterile hyphae, and which certainly had every appearance of being so, were really conidiophores bearing terminal and lateral uniseptate conidia, the latter either sessile or on short branches.

Some of the erect hyphae which had not been truncated became enormously long (fig. 3), and bore conidia laterally, sometimes sessile and sometimes on short branches.

The conidia never appeared in chains nor were the conidiophores nodulose, hence the fungus is not a *Cladotrichum* but a *Cladosporium* and so should be called CLADOSPORIUM MYRMECOPHILUM nov. comb.

All the different forms of conidium on germination usually produced a nodulose form of hypha (fig. 4).

HORMISCIUM PITHYOPHILUM (Wallr.) Sacc. var. MYRMECOPHILUM (var. nov.).

About two years ago Mr. Donisthorpe* found that the ants of the species *Lasius umbratus* also constructed carton cells of

* Donisthorpe. Myrmecophilous notes for 1913. Entomologists' Record, Vol. XXVI., No. 2, page 40.

a dark earthy brittle substance similar to that of which the nests of *Lasius fuliginosus* were formed, and after finding that the carton also contained fungus hyphae, very kindly sent me some to examine.

These ants *(L. umbratus)* build small nests underground among the roots of trees, etc., where they construct only a few cells of this carton, making it by cementing together with saliva, fragments of wood fibre, sand, earth, etc. (fig. 5).

It forms a very favourable substratum for the fungus which grows so luxuriantly that it becomes the predominant feature, and because of its dark olive green colour gives the carton the characteristic blackish appearance.

The fungus is a species of *Hormiscium* very much resembling *Hormiscium pithyophilum;* it has a similar dark olive green colour, in masses appearing black, but it has a creeping habit, forming long branching chains of cuboid or oblong conidia which rarely become separate (fig. 6).

The conidia are at first very pale olive, quite smooth and transparent, but later they become somewhat opaque and rather rough; their size is very variable, the cells of the conidial chains varying in diameter from 8μ to 14μ, and in length from 10μ to 20μ. Each cell has one or more large oil drops present.

In cultures† the cells of the chain rarely become isolated, but on doing so, they become quite spherical (figs. 7 & 8), and on germination either produce similar long chains of conidia (fig. 9) or hyphae of wide dimensions from which conidial chains arise (fig. 10).

It will be seen that this fungus differs from *Hormiscium pithyophilum* Sacc. only in the slight roughness of the spores and in having long creeping branches, instead of short curved branches becoming thinner at the tips; this may be due to difference in habit since *H. pithyophilum* is found forming thick superficial patches on the leaves of pines, firs and yews. With reference to this, it may be noted some of the nests of *L. umbratus* are found at the roots of decayed conifer trees or in the ground in the vicinity of conifer stumps, so the origin of the fungus in the carton may possibly have been infected pine needles.

Considering the habitat and the somewhat different appearance of the fungus it seems appropriate to call it *Hormiscium pithyophilum* var. *myrmecophilum.*

Just as the species of fungus associated with the carton of *Lasius fuliginosus* is always the same, so in the case of *L. umbratus*, the above described species of *Hormiscium* is always found to be present in the carton, no matter to what locality the nest from which it was taken belonged.

† Hanging-drop cultures of fragments of carton moistened with water.

It has been suggested in the case of *L. fuliginosus* that the ants cultivate the fungus and feed their larvae on it, but notwithstanding the abundance of the fungus in the *Lasius umbratus* carton, Mr. Donisthorpe considers it would not be sufficient food alone for the brood, though probably the ants do make use of it, as it is easily accessible, using it to supplement their other food, which consists largely of small insects and the excreta of aphides. In fact he considers it is probably the absence of this fungus which makes it exceedingly difficult to rear larvae of this species, while on the other hand, larvae of species of *Lasius* which do not make carton he has reared from the egg to the perfect state in a few months.

Perhaps the more important function of the fungus in the carton is that of giving stability to the walls of the nest, for the ramifications of the fungus hyphae must help considerably in binding the particles of sand, fibre, etc., together.

This carton fungus must not be confused with the well-known " fungus gardens " found in the nests of the white ants of Ceylon, India, etc.; nor yet with those of the South American leaf-cutting ants.

According to Petch* the nests of the white ants contain numerous chambers in which are found coarse sponge-like structures or " combs " composed of finely divided wood or other vegetable matter which has been digested by the ants and is in fact excrement. On these " combs " a fungus grows, hence the name " fungus garden."

The " fungus gardens " of the leaf-cutting ants are similar comb-like structures and when investigated by Möller† were found to consist of the small fragments of leaves formed into minute balls and packed together into a spongy mass; in the course of time the spongy mass becomes interpenetrated by the mycelium of a fungus *(Rozites gongylophora)*.

In these cases the fungus seems simply grown for the purpose of food and does not occur in the walls of the nest, and so unlike the carton fungus has nothing to do with strengthening them.

The leaf-cutting ants make an excellent provision for infecting the " fungus gardens " of new colonies with fungus from the old colony; according to Von Ihering,‡ a tiny ball of the old " garden " is carried away by the young queen in her infra buccal chamber when she goes out for her marriage flight, and is deposited in the hole made for the new brood, and until the

* Petch. Termite Fungi: a Résumé. Annals R.B.G., Peradeniya, Vol. V., Part V., 1913.

† Möller. l.c. page 22.

‡ Von Ihering. J.R.M.S., page 299. New Colonies and Fungus Gardens. Zool. Anzeig., XXI. (1898), pp. 238-55.

first batch of workers is hatched out she attends to its welfare herself; probably a similar arrangement exists with the above-mentioned two species of *Lasius* which make carton; and may thus account for the constant association of definite species of ant and fungus.

Since the fungus exists in the carton as a pure culture, all "foreign" fungi are doubtless "weeded" out, as in the fungus gardens of the white ants and leaf-cutting ants, for many varieties of fungus spores must be introduced into the nests by the passing of insects in and out.

In conclusion I wish to express my thanks to Mr. H. Donisthorpe for drawing my attention to these fungi, and also to Prof. G. S. West, Mr. Carleton Rea, and Mr. Grove, for the loan of various books and pamphlets which I have used for reference.

H. pithyophilum (Wallr.) Sacc.
v. *myrmecophilum* var. nov.
var. ramulis, non apice attenuatis, cellulis leniter asperulis.
Hab. in nidis *Lasii umbrati*.

Explanation of Plate.

The carton from the nest of *Lasius fuliginosus*.

Fig. 1. Small portion of carton teased out showing
a, nodulose creeping hyphae.
b, erect hyphae, truncate.
c, uniseptate conidium.
d, unicellular conidium.
e, branched erect hypha, × 312.
f, unicellular conidium, sessile on nodulose creeping hypha.

Fig. 2. Carton after being moistened and kept in a hanging drop for a few weeks showing erect hyphae (conidiophores) with conidia attached, × 312.

Fig. 3. Erect hyphae which have grown to a great length in a hanging drop bearing lateral conidia, sessile or shortly stalked, × 312.

Fig. 4. Two-, three-, and four-celled conidia, some germinating and producing nodulose hyphae, × 312.

Carton from the nest of *Lasius umbratus*.

Fig. 5. Carton showing ramifying chains of conidia, grains of sand and wood fibre, × 85.

Fig. 6. Chains of conidia, × 312.

Fig. 7. Cells of a conidial chain rounding off, × 312.

Fig. 8. Conidium, × 312.

Fig. 9. a, b, c } Germinating conidia, × 312.

Fig. 10. Conidial chains arising from a hyphae produced from a conidium, × 312.

J. S. Bayliss Elliott del.

1-4 Cladosporium myrmecophilum (Fres.)

5-10 Hormiscium pithyophilum (Wallr.) Sacc. var. myrmecophilum.

THE GENERIC NAME PROTASCUS.

By J. Ramsbottom, M.A.

Dangeard (C.R. Acad. Sci. CXXXVI, p. 627, 1903) described a Chytridiaceous fungus parasitic on Anguillules. This he regarded as the type of a new genus resembling *Myzocytium* and *Lagenidium* in structure. Instead of producing zoospores, however, the sporangium forms a number (8, 16 or 32) of definitely orientated immotile spores which are abruptly ejected from it. Dangeard gave the name *Protascus* to the fungus because he was of the opinion that its method of sporulation showed affinities with that of the Ascomycetes. The particular species under consideration he named *Protascus subuliformis.*

Wolk (Mycol. Centralb. III., p. 153, 1913) gives the name *Protascus* to a fungus which he describes as causing the "yellow grains" of rice. He places the genus in the sub-order Endomycetaceae of the Protoascineae. The asci are borne at the end of a septate mycelium and contain an indefinite number (2-15) of dark coloured spores, which finally become septate. The drawings of the septate spores show 1-2 septa, but the author is "inclined to regard the cell-multiplications as a degenerative phenomenon." The asci are not sexually produced: in some cases they exhibit outgrowths which continue like ordinary mycelial threads, so that in older cultures the asci appear to have had an intercalary formation. Because of the colouring effects the particular species has on rice Wolk gives it the specific name *colorans.*

In neither case is there either a generic or specific description. It is certainly not sufficient for accurate identification of a species to have a general account without measurements of any part of the fungus, and it is much to be regretted that any mycologist should neglect to give an intelligible description of the fungus which he has investigated. The obvious way is to draw up a Latin diagnosis in the usual manner. Without a Latin diagnosis, in fact, the International Rules of Botanical nomenclature go so far as to say, a name cannot stand. ("Art. 36. On and after January 1, 1908, the publication of names of new groups of recent plants will be valid only when they are accompanied by a Latin diagnosis.")

It is evident that the name *Protascus* must be retained for the fungus described by Dangeard. For Wolk's genus I propose the name *Wolkia*. The species causing "yellow grains" of rice is *Wolkia decolorans* (Wolk), and the fact that its mycelium is light pink when immature and the young asci darker pink, taken together with its habitat will probably assure its specific identification.

No reference having been found to the fact that the name *Protascus* was already occupied, it has been considered advisable (owing to the possibility of the confusion arising in discussions on the origin of the Ascomycetes) to call attention to it here.

GUTTULAE IN SPORES OF DISCOMYCETES.

By J. Ramsbottom, M.A.

Hedwig (1789), who first described the ascus with its eight spores in Discomycetes, figured oil drops clearly in several species (*e.g.*, one in *Octospora leucoloma* and many in *O. hirta*). He called them "Kügelchen," and "Körnchen," and does not seem to have assigned any special function to them.

Persoon (Traité sur les Champignons comestibles, 1818, p. 31) writes concerning the ascospores: "Quelques mycologues les considèrent comme des *capsules* desquelles ils assurent avoir vu sortir, dans quelques circonstances une matière qui, selon eux, sont les semences proprement dites." These authors doubtless had the guttulae in view: but with the increase in the power of the microscope, many observers did not hesitate to assume that greater magnifications would reveal further structures within spores.*

Berkeley, in the English Flora (1836), used the name sporules for basidiospores, but alters his terminology when dealing with the other groups to agree with that of Fries and Greville. In a footnote on page 183 he writes: "When the granular mass with which the vesicles are filled is collected into one or more distinct bodies, as in some *Pezizae*, the bodies will be called *sporidiola*, the name of Sporules being reserved for the individual grains analogous to embryos of which the nucleus is composed."

* *Cf.* Trans. Brit. Mycol. Soc. IV., p. 85 (1913).

The presence of guttulae in certain species is so apparent and so constant that they have figured in specific diagnoses for practically a century. Boudier has laid special stress upon the presence or absence of oil-drops. In his most recent paper† he writes: "Bien qu'il ne faille pas se dissimuler que la fixité de ces gouttelettes soit loin d'être constante, tous nous avons observé le contraire, mais il n'en existe pas moins des règles qui non seulement sont pour beaucoup de mycologues un excellent critérium pour la distinction des genres et des espèces, mais encore par cela même un des moyens les plus utiles pour les caractériser." A glance at the generic key to the Discomycetes published in the last volume of the Transactions of this Society will indicate the importance which this eminent authority attaches to guttulae as generic characters. He regards them as having great biological importance, as they are reserve food material for the germinating spore. That there is some variation in any given species is well known to all who have paid any attention to the matter. "On doit donc toujours avoir grand soin d' examiner un certain nombre de spores pour établir son jugement, sans cela on risquerait fort de commettre des inexactitudes toujours préjudiciables à la science si on ne bornait son examen qu' à un petit nombre, comme aussi de ne les examiner que lorsqu' elles sont sorties naturellement des thèques, celles qui y sont incluses étant très fréquemment immatures et par conséquent pouvant présenter des différences qui pourraient induire en erreur, tant au point de vue de ces guttules qu' à celui des cloisons qu'elles peuvent présenter." Boudier points out that the oil drops are dissolved by tincture of iodine and by alcohol, observations which are readily confirmed. "Il faut se rappeler aussi que les descriptions faites sur des échantillons desséchés ou conservés dans de l'alcool seront toujours ou risqueront d'être fautives ou incomplètes, par les modifications que peuvent leur faire subir les liquides dans lesquels les exemplaires auront été plongés, et l'on doit toujours se mettre en garde contre ces erreurs."

During the examination of fresh specimens of *Peziza rutilans* three or four years ago the present writer noticed that the conspicuous guttulae disappeared overnight in a section mounted in glycerine, and this observation has been confirmed since in a large number of species. It did not seem possible that such a fact had not been previously observed, but the first reference* was not found until recently when reading through the papers of M. C. Cooke in preparing an obituary notice. "Those

† De l'importance que l'on doit attacher aux gouttelettes oléagineuses etc. Rév. Gen. de Bot. XXV. bis pp. 51-54.

* M. C. Cooke. On nucleated sporidia. Journ. Quekett Micros. Club, II., p. 251 (1871).

who have viewed the sporidia of *Peziza*, especially of such a species as *P. lanuginosa*, will have noted that the presence of 'nuclei,' as they are termed [i.e., guttulae], is so universal in certain species, and apparently so permanent, that they have been introduced into the diagnoses of species. In the case of *P. lanuginosa*, the sporidia are large, and with two or more nuclei. . . . Specimens were mounted in glycerine last year . . . and when mounted, all the sporidia had nuclei, some with one or two large, and two or three smaller nuclei, but all were nucleate. Examining the specimen again in a few weeks, I found that all the smaller nuclei had disappeared, and only large nuclei could be seen, whilst some sporidia were without nuclei. During the past week I have examined the slides again, but amongst all the sporidia, whether free or still enclosed in their asci, not a single sporidium can be detected in which a nucleus is visible."

The time mentioned by Cooke as requisite for the disappearance of the guttulae differs from that in my experience, a period of at most a few hours having always sufficed to remove all traces of the oil drops.

The importance of the observation lies in the fact that slides of Discomycetes in herbarium collections are usually mounted in glycerine, and hence this must be taken into account in critical examinations. In no case have guttulae been observed in the collection of Discomycete slides preserved in the National Herbarium.

NEW MARINE PYRENOMYCETES.

PLATE III.

By Geo. K. Sutherland, M.A., B.Sc.

INTRODUCTION.

To our knowledge of the marine Pyrenomycetes little has been added since the discovery of their existence nearly a century ago. Isolated species, collected incidentally, have been described at long intervals with the result that little is known as to their numbers, distribution or development. Consequently, no inclusive nor coherent account is available. In 1907, Cotton, while describing *Mycosphaerella Ascophylli* Cotton and the pycnidial stage of *Leptosphaeria Chondri*, took the opportunity to survey briefly the position up to that date. He included all the known marine Pyrenomycetes in a list of nine species. Of these, only two, collected by himself, are recorded for Britain.

During the past year the writer has collected and obtained algal material from various parts of the coast of Britain, in which a number of new species and even new genera have been found. The shores of Orkney yielded the richest harvest, but that may be due to the more careful search and the excellent and varied facilities for prosecuting it. Four of these occurring in Pelvetia alone, have been described recently.* To these may now be added the three treated briefly in the present account. Several others are under observation and examination, thus more than doubling the number hitherto noted and investigated.

OPHIOBOLUS LAMINARIAE, nov. sp.—(Pl. III., fig. I., 1-4).†

Perithecia densely crowded, remaining embedded in tissue with tip of long cylindrical beak merely breaking through, irregularly spherical and flattened, large, 350-450μ in diameter.

* Sutherland.—"New Marine Fungi on Pelvetia," New Phytologist, Vol. 14, Feb. and Mar. 1915.

† Perithecia dense conferta, continue immersa, ostiolo elongato cylindraceo, apice solo erumpente, subsphaeroidea vel complanata, magna, 350-450μ diam., contextu coriaceo, atro; asci cylindracei, curvati, octospori, 300-360μ x 20-22·5μ, aparaphysati; sporidia filiformia, ascos subaequantia, hyalina, 50-75-septata, tandem in articulis cylindraceis (5-6μ x 5·5-6·5μ) truncata.

Hab. In thallo putrescente *Laminariæ digitatae*, Orkney.

Perithecial wall thin, leathery, black. Asci cylindrical, curved, 8-spored, 300-360μ x 20-22·5μ. Paraphyses absent. Spores filamentous with numerous (50-75) cross-walls, hyaline, 300-350μ x 5·5-6·5μ, breaking up later into cylindrical portions 5-6μ long by 5·5-6·5μ broad.

On stalks of *Laminaria digitata.*

The specimens examined were collected from various parts of the north and east coasts of Scotland, where the fungus occurs abundantly on detached plants lying in rock pools. Sections of occasional blackened spots on attached, actively-growing Laminaria revealed the presence of corresponding mycelium, accompanied, however, invariably by bacteria and sometimes by one of the Dematiaceae. The presence of these two, growing luxuriantly on the outer cortical layers, prevents any definite conclusion being drawn as to the power of this fungus to gain entrance by itself.

The mycelium penetrates to the mucus-passages, whose anastomosing tubes, full of mucilage, form ideal centres for rapid development and extension. Long, black, septate hyphae, with an average diameter of 10-15μ, although 20μ is not uncommon, run along these ducts sending numerous branches into the outer layers towards which nearly all bend. Their passage through the cells presents the appearance of irregular nodulose lines, owing to the alternation of hyphal dilations in the cells with constricted portions passing through the walls. These branches, varying from 4-7·5μ in diameter, give rise to still finer hyphae, 2-3μ, which form a dense network in the cortex. There seems to be little or no attempt to attack the zone beneath the ducts with the result that a sharp separation of these two tissues occurs later.

The perithecia are formed at the tips of special branches about 300-350μ below the epidermal layer, and are densely crowded all over the infected area. The mature perithecium is a relatively large body easily visible to the naked eye; some of the largest approach 0·5 mm. in diameter. In outline it presents a flattened irregular spherical appearance with a long cylindrical beak 175-275μ x 65-70μ. The latter breaks through the outer layers but without projecting. The perithecial wall is thin, black and leathery. Neither periphyses nor paraphyses are present.

The long cylindrical thin walled asci are strongly curved owing to their great length. They become free at an early stage and are coiled inside the perithecium. The long filamentous septate spores lie parallel and completely fill the ascus whose length they practically equal. At first they are unseptate, but at maturity numerous cross walls are formed, and finally each spore breaks up into short cylindrical portions which pass out through the ostiole.

The systematic position of the fungus is open to question, and it has been placed in the genus Ophiobolus only after considerable hesitation. The delicately walled asci, with their filamentous spores breaking up later, are characteristic of Ophiobolus. The absence of paraphyses, however, would tend to refer it to the family Mycosphaerellaceae, in which there is no genus with similar spores. A disclination to create a new genus on such a character alone has prevented me from describing it as such, although there is abundant precedent, as for example in the separation of Stigmatea from Mycosphaerella. The inclusion in the genus Ophiobolus of one or two forms wanting paraphyses, as *O. maritimus* would seem to justify this naming, while at the same time it bears eloquent testimony to the unsatisfactory condition of classifications of the Pyrenomycetes. The long cylindrical beak differs also from the type generally met with in Ophiobolus. The simplest way out of the difficulty would undoubtedly be the creation of a new genus, but that is undesirable, in the writer's opinion, until the life history is fully investigated.

TRAILIA, nov. gen.*

Stroma wanting. Perithecia deeply sunk in substratum, with tip of long narrow straight or curved cylindrical beak or ostiole breaking through surface, but not projecting. Wall of perithecium soft and white. Asci cylindrical and curved with thin membrane, 8-spored. Paraphyses absent. Spores hyaline, filamentous, tapering, septate, bent double and coiled in ascus.

TRAILIA ASCOPHYLLI, nov. sp.—(Pl. III., fig. II., 1-3).†

Mycelium localised, hyaline, septate. Perithecia grouped irregularly in blackened regions of thallus, spherical or club-shaped, 50-60μ in diameter with long narrow straight or bent cylindrical beak 300-450μ × 7·5-10·5μ. Perithecial wall thin, soft, and white. Asci cylindrical and curved, thin-walled, 8-spored, 45-50μ × 9-10μ. Paraphyses absent. Ascospores filamentous, tapering from 3-3·5μ at broad end to 1μ at narrow

* Stroma nulla; perithecia simplicia, thallo alte immersa, mollia, alba vel pallida, ostiolo longissimo, angusto, recto vel curvato, cylindraceo; asci cylindracei, octospori, aparaphysati; sporidia hyalina, filiformia, fastigata, septata, in asco duplicata contortaque.

† Mycelium in quibusdam locis, hyalinum; perithecia conferta vel sparsa, thalli regionibus inaequaliter atris factis immersa, subglobosa vel clavata, 50-60μ diam., mollia, alba, ostiolo longissimo, angusto, recto vel curvato, 300-450μ longo, 7·5-10·5μ lato; asci cylindracei, contorti, octospori, 45-50μ × 9μ, aparaphysati; sporidia hyalina, filiformia in exilitatem fastigata, septata, altero tanto asco longiora, et igitur duplicata contortaque.
Hab. In thallo *Ascophylli nodosi*, Orkney.

end, hyaline, septate, twice the length of ascus and, consequently, bent double and coiled.

Parasitic on thallus of *Ascophyllum nodosum.*

This fungus, observed for the first time in Orkney during the summer and early autumn of 1914, was found occurring in great abundance on the thallus of *Ascophyllum nodosum* just to the outside of the Pelvetia zone on the flat rocks. It was also obtained on free-floating masses in the North Sea.

At first circular patches of brown appear, giving place later to irregular dark blotches which stand in striking contrast to the pale olive of the healthy thallus. The spread of the disease is rapid, and frequently it renders portions of the thallus so brittle as to be easily broken off by the action of the waves. Once the fungus has broken the epidermal layer, the host is exposed to the action of various bacteria. These latter working in consort with the parasitic fungus kill and break down the outer tissue destroying protoplasm and chloroplasts. The result is that frequently the thallus, in section under the microscope, is seen to be surrounded by a hyaline envelope of disorganised tissue, permeated by branching hyphae and bacterial masses.

The hyaline mycelium, consisting of fine septate strands with a diameter varying from 1·5-2μ in the finer branches to 3μ and occasionally more in the main ones, forms a closely woven network throughout the tissue of the infected areas. The finer hyphae are difficult to distinguish, at first glance, from the mycelium of *Mycosphaerella Ascophylli* Cotton with which I have invariably found them interwoven. The slightly greater thickness of the main branches and the habit of both makes it easy to differentiate them. The parasitic species, in addition to occupying the intercellular spaces, coils branches tightly round the protoplasmic contents into which slightly dilated haustoria are sent, or through which absorptive branches pass. Azo-blue is quite effective in singling these out.

The perithecia are produced deep within the tissue, sometimes being found in the very centre of the thallus. As a rule they are scattered irregularly, but frequently three or four are grouped together, generally at different levels. They are minute bodies rarely exceeding 50μ in diameter. Owing to their depth within the host they require long ostioles. Thus in the case of one young perithecium the developing beak had reached a length of 245μ with about another 300μ to travel to the surface. This characteristic, long, attenuated neck seems out of all proportion to the size of the body. Usually it grows straight outwards in the form of a cylindrical tube of about 8 or 9μ in diameter, consisting of loosely woven hyphae, but, whenever the perithecium is bent over, it curves gradually upwards. It is quite a common occurrence for perithecia em-

bedded in the tissue of the air bladders to grow towards the enclosed cavities, and in that case the ostioles usually project into these in a curiously bent worm-like fashion with slightly swollen tips. Normally, however, they penetrate the cortex and reach the surface beyond which they never project.

The perithecial walls remain soft and white. This character is maintained even in the superficial layers when the epidermis and outer cortex have been destroyed as already described.

The asci are few in number, and bunched together. When young, they are tapering and relatively thick-walled, later becoming thin-walled and cylindrical, with a slight constriction at the curve above the thickened lower end. The spores are most distinctive. They are hyaline and twice the length of the ascus. This necessitates their being doubled and coiled in the manner characteristic of the genus. The filamentous and tapering spores, at first unseptate, ultimately develop 1-3 septa in the wide end. None have been observed so far in the narrow end. When released from the ascus they retain a characteristic coiled attitude which gives them a distinctive snake-like appearance. This may assist in their passage through the long, narrow ostiole.

The formation of a new genus to include this fungus is clearly necessary. Not only does the character of the perithecium separate it from all other genera of the Hyponectrieae among which it must be placed; the type of spore is also distinct.

ORCADIA, nov. gen.*

Stroma absent. Perithecia entirely immersed in thallus of host with long tapering beak. Perithecial wall soft, white never becoming black. Asci cylindrical or clavate, 8-spored. Paraphyses present. Spores septate.

ORCADIA ASCOPHYLLI, nov. sp.—(Pl. III., fig. III., 1-3).†

Mycelium localised, hyaline, forming network on which fruiting bodies are borne. Perithecia entirely sunk in thallus, spherical or arched, 160-200μ in diameter, with long broad cylindrical beak 80-125μ × 35μ. Asci clavate, thin-walled, 8-

* Stroma nulla; perithecia simplicia, thallo immersa, contextu distincte molli pallidoque (nunquam carbonaceo), ostiolo elongato, fastigato; asci cylindracei vel clavati, octospori, paraphysati; sporidia hyalina, septata.

† Mycelium in quibusdam locis, hyalinum; perithecia thallo omnino immersa, globosa vel arcuata, mollia, pallida, 160-200μ diam., ostiolo elongato, lato, cylindraceo, 80-125μ longo, 35μ lato, ad superficiem pertinente; asci clavati, octospori, 65-75μ × 17·5-18μ; periphyses numerosae; paraphyses paucae, filiformes, simplices; sporidia tempestiva flavescentia, cylindracea, parum curvata, 3-septata.

Hab. In thallo vivo *Ascophylli nodosi*, Orkney.

spored, 65-75μ × 17·5-18μ. Periphyses abundant, paraphyses few, filamentous, unbranched, with slightly dilated tips. Ascospores light yellow when mature, cylindrical, slightly curved, 3-septate.

Parasitic on thallus of *Ascophyllum.*

This fungus was also found in great abundance on *Ascophyllum nodosum* along the shores of the Orkney islands during the summer of 1914. In external appearance the disease presents a strong resemblance to the damage caused by Trailia The blackened patches, at first circular, become irregular in outline and run into one another so that finally whole areas of the thallus show infection. The fungus aided again by bacterial action, causes a similar breaking down of the epidermal and outer cortical layers, and, in these, various bacteria and fungi find a footing.

This pale coloured mass of disorganised cell walls, stains distinctly with azo-blue, but fails to show any reaction with iodine, as in the case of a similar layer in Stigmatea on Pelvetia.

The mycelium, consisting of numerous, slender, much-branched, curved hyphae 2-3·5μ in diameter, is strongly developed. It forms a very dense somewhat cylindrical network round the algal cells, which are strangled by close coils or penetrated by haustoria. This habit enables us to distinguish it from the endophytic non-parasitic mycelium of Mycosphaerella, but gives no aid in separating it from that of Trailia, with which it is sometimes associated. When the three occur together the thallus becomes simply riddled with hyphae.

The perithecia, produced irregularly in the cortex, are spherical or arched with long, cylindrical, slightly tapering beaks, level with the surface except where, owing to the decay of the upper layers, they may project for a very short distance, rarely more than 5-10μ. The perithecial walls consist of closely woven, fine, hyaline hyphae remaining soft, fleshy and white. They never become black even when the ostiole projects slightly. Numerous asci are present, mixed with sparse short paraphyses slightly dilated at the tips, and surrounded by numerous periphyses. The 3-septate spores tend to break easily into sections.

Arising from similiar mycelium, which penetrates the disorganised outer tissue, are short unbranched conidiophores cutting off elliptical hyaline conidia 6-8μ × 3μ. While the mycelium bearing them is similar to, and appears to spring from that bearing the perithecia, it is inadvisable to designate this the conidial form of Orcadia without further investigation

The septate spores correspond to those of Leptosphaeria, but the structure of the perithecial wall taken in connection with the elongated soft beak, may be regarded as sufficient

reason for considering it distinct. The occurrence of hard, black perithecia of the Sphaeriales type on Pelvetia, Laminaria, etc., prevents our regarding this as a Leptosphaeria whose walls remain soft and whitish owing to the different conditions met with in algal hosts. Its natural position in our present artificial classification is undoubtedly among the Hypocreales near Trailia to which it bears a resemblance both in the soft whitish walls and its total immersions in the host tissue. Taking these points into consideration, it seems desirable to make this generic separation.

The foregoing, added to the other four new Pyrenomycetes recently described by the writer, make seven new species, two of which are also new genera. The investigation so far has revealed some interesting characters and adaptations, which it is hoped to link into a coherent whole when the present examination of species is complete.

Appended are diagnostic characters and brief preliminary notes on two other new species still under observation. Special interest attaches to the former of these, Hypoderma, as, so far as the writer is aware, this is the first record of the occurrence of any of the Hysteriineae on marine algae.

HYPODERMA LAMINARIAE, nov. sp.

Perithecia in areis rotundis gregaria, immersa, longo-elliptica, apicibus aliquid praeacutis, 150-220μ longa, circa 130μ lata, scissuris longis aperientia, parte superiori atra, carbonacea, basi submembranacea, pallide brunnea; asci clavati, apice attenuato, 69-90μ × 12·5-14μ, octospori; paraphyses filiformes, extremibus leviter inflexis vel dilatis; sporidia disticha, fusiformia vel ovoidea, hyalina, 1-septata, leviter constricta, flavescentia, 20-25μ × 5-7·5μ.

Hab. In thallo vivo *Laminariae saccharinae*, Orkney.

During the summer and autumn of 1914 this fungus was found in great abundance along the shores of the Orkneys, where its occurrence on living plants, both attached and newly cast up after storms, fully bears out its parasitic habit.

The first appearance of the disease is indicated by small brown discoloured patches on the stalk; these gradually extend and darken, forming circular or somewhat elongated areas, which ultimately merge into one another. On examination they prove to contain immense numbers of densely crowded, oblong, irregular, or even branched perithecia with the habit and mode of opening characteristic of the Hysteriineae.

The dark-coloured, thick-walled, irregular mycelium penetrates in wedge fashion between the mucilaginous cell walls of the outer cortical region. Haustoria enter the cells and absorb their contents. In this way the outer layers are ultimately

broken down, exposing the inner to the action of numerous saprophytes. The perithecia are formed in the cortex immediately underlying the epidermis, along which are laid down the dark streaks which split later to form the thick-lipped openings. These are carbonaceous, while the lower portions of the perithecia are merely membranous. Lining the wall are several layers of pale-coloured mycelium from which the asci and paraphyses spring. The former, rising from the somewhat flattened base, show great variation in outline and in the arrangement of the ascospores within them. The paraphyses are filamentous and bent towards the tips. The uniseptate thick-walled spores are hyaline when young but become slightly coloured at maturity.

DOTHIDELLA PELVETIAE, nov. sp.

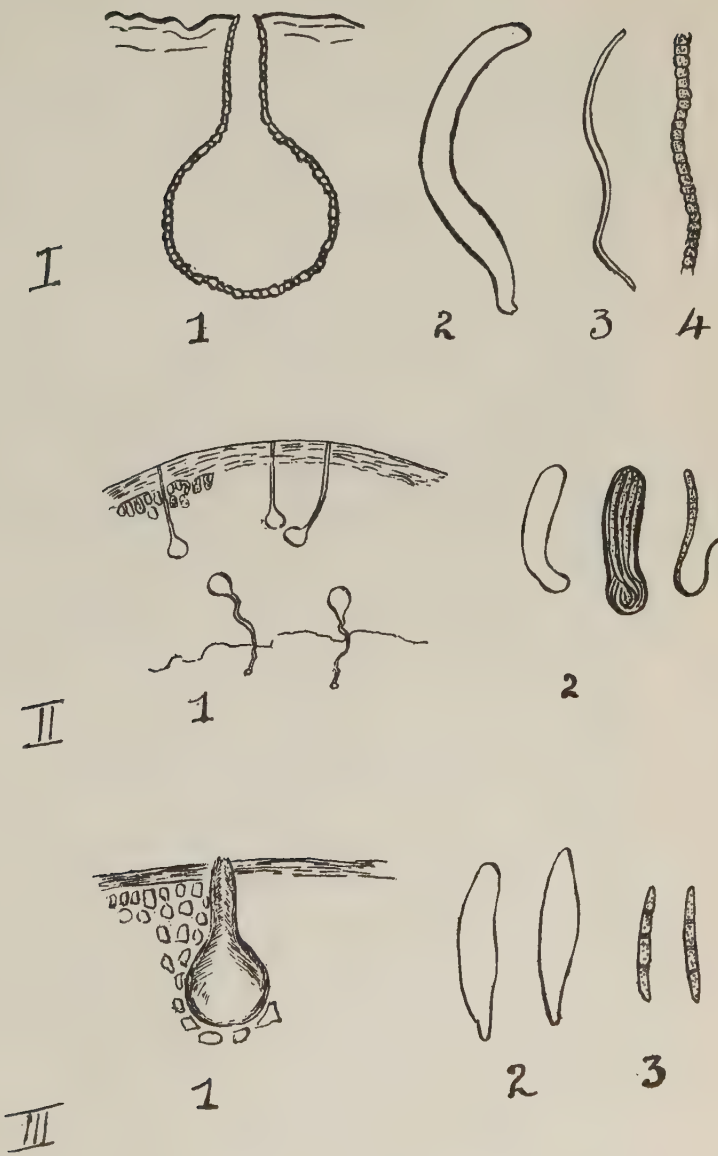
Stromata sparsa, parva, 210-650μ diam., convexa, initio immersa tandem in summa parte, atra; loculi immersi, subglobosi vel complanati, 100-120μ lati, 80-90μ alti; asci cylindracei vel clavati, octospori, 40-45μ × 12-15μ, paraphysati; sporidia disticha, ovoidea vel oblongata, hyalina, 1-septata, vix constricta, tegumento denso, 12·5-15μ × 5-6μ.

Hab. In thallo *Pelvetiae canaliculatae*, Orkney.

This fungus was found on cast-up and dried thalli of Pelvetia, and consequently it is uncertain yet whether its habit is parasitic or saprophytic. An extensive examination of attached and living plants in that particular locality has so far failed to show any trace of the fungus. As the infected thalli may have been sea-borne, this absence does not prove conclusively that the fungus does not occur elsewhere as a parasite.

The stromata, produced in the epidermis and the layers immediately underlying it, ultimately become superficial through the breaking down of these layers by various organisms. They are relatively small bodies, rarely exceeding 0·5mm. in diameter, and containing frequently only one loculus. Seldom, even in the largest stromata, are more than 3 to 5 found. The loculi are small and generally flattened, flask-shaped bodies with numerous asci and paraphyses borne on the basal portions. The former are cylindrical or clavate, with two membranes, the outer of which usually splits transversely. They contain eight, oval or oblong, two-celled, biseriate spores, which are much smaller than those of *Dothidella Laminaria* Rostr., found on the stipes of *Laminaria longicruris* in Greenland.

University College,
Southampton,
February 1915.



G. K. Sutherland. del.

I. Ophiobolus Laminariae. II. Trailia Ascophylli.
III. Orcadia Ascophylli.

Explanation of Figures. Plate III.

I. 1. Perithecium of *Ophiobolus Laminariae.*
2. Ascus
3. Immature ascospore
4. Portion showing cross walls.

II. 1. Section of air bladder wall of Ascophyllum showing perithecia of Trailia.
2. Asci.
3. Ascospores.

III. 1. Perithecium of *Orcadia Ascophylli.*
2. Asci.
3. Ascospores.

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NEW OR RARE MICROFUNGI.

By A. Lorrain Smith, F.L.S., and J. Ramsbottom, M.A.

We are again indebted to Mr. D. A. Boyd for forwarding to us the interesting microfungi he has gathered, and have the greatest pleasure in dedicating to him certain of the new species which have become known through his painstaking search. Miss E. Dale has continued her valuable work on soil fungi.* It is to be regretted that some of the descriptions given would seem to be useless for the re-identification of the species found. It does not seem advisable to record the presence of a fungus in soil cultures of which neither the genus nor species is certain, since if suitable methods of culture be adopted the majority of saprophytic fungi would doubtless appear, owing to the universal occurrence of their spores. In those cases where a species has been definitely identified we have given a description as far as possible from the original publication.

In the opinion of the authors of the present paper it is a matter of surprise that all the accepted conventions of systematists should be so often disregarded by those studying the biology and life histories of fungi; a short description of the essential characters of a new species or form encountered would save the trouble in many cases of wading through pages of wordy description in the attempt to discover the reasons for the new determination.

PHYCOMYCETES.

Mucor Glomerula Lendner, Mucor. Suisse, p. 69 (1908), *Glomerula repens* Bain.

Sporangiophores erect, much branched; each upright branch ending in an often more voluminous sporangium, below which occurs a verticil of 3-8 secondary filaments each terminated by a sporangium, and each giving rise in its turn to a verticil of 3-5 sporangiferous filaments. Aerial mycelial filaments often terminated by branches which also bear almost sessile sporangioles. Sporangia spherical, colourless, becoming sienna-coloured when old; membrane encrusted with calcium oxalate, diffluent leaving a collarette; columella of various forms,

* *Cf.* Trans. Brit. Mycol. Soc. IV., p. 165 (1913).

hemispherical, cylindro-conical, ovoid, sometimes very narrow, fairly brusquely inserted on the dilated extremity of the sporangiophore. Spores round, smooth. Aerial chlamydospores rounded, with thickened membrane, yellowish and asperate; contents oleaginous; immersed mycelial chlamydospores similar, but more numerous. Zygospores unknown.

In cultures of chalky soil, E. Dale, in Ann. Mycol. XII., p. 35 (1914).

According to Miss Dale the sporangia are about 70μ in diameter and the spores vary in size, but are usually small (2-4μ).

M. Lausannensis Lend. Tom. cit. p. 75.

Sporangiophores erect, little branched, laterally subracemose, 5-10 mm. long × 10-14μ wide. Sporangia 40-45μ in diam., often with flattened base; membrane fragmenting as in *M. racemosus*, leaving at the base of the columella an irregular collarette; columella oval or spherical, 30-40μ × 50μ. Spores oval, very variable in size, 4-12μ × 2-6μ (average 8μ × 6μ); hyaline, almost colourless, slightly yellowish in mass. Chlamydospores somewhat rare, forming on the mycelium or on the sporangiophores, 16μ × 14μ, smooth with granular contents. Zygospores unknown.

In cultures from chalky soil and reclaimed fen-peat. E. Dale tom. cit., pp. 36, 55.

According to Miss Dale the sporangia vary in size from 15 to 80μ (average 30-40μ), the spores 1-2μ × 5-8μ (average 5μ), and abundant chlamydospores are produced in the vegetative mycelium.

Absidia glauca Hagem, Vidensk. Selsk. Skrift I., p. 43 (1907).

Fungus at first white then ± bluish-green; creeping hyphae sympodially branched with the main axes many cm.s long, robust, up to 25-30μ in width, provided with rhizoidal hyphae; hyphae bearing the sporangia erect, sometimes simple or more usually in pairs, 100-600μ × 5-10μ, laterally branched and bearing a sporangium at the apex. Sporangia pyriform, 44-60μ × 40-50μ, with a diffluent membrane incrusted with granules; columella subhemispherical, submamillate, with an apiculus at the apex, mostly constricted at the base. Spores globose, 2·5-3·5μ diam., yellowish or hyaline. Heterothallic. Zygospores globose, of various sizes, mostly 100μ in diam., opaque, black, exosporium with wide flat warts.

In cultures from chalky soil, E. Dale, tom. cit., p. 36.

" This species is in young cultures at once distinguished from *Absidia Orchidis*, which in many respects it closely resembles,

by its characteristic blue-green colour, whereas that of *A. Orchidis* is a delicate violet."

DISCOMYCETES.

Discinella minutissima Ramsb. et Garn. in Journ. Bot. LII., p. 216 (1914).

Receptacles very minute, 300-400μ wide, isabelline, substipitate, fleshy, thick, with an obtuse, non-prominent margin, obconical; paraphyses slender, 2-3μ wide, with oily contents, simple, filiform, not or scarcely thickened at the apex, hyaline; asci inoperculate, eight-spored, with marginate foramen, cylindrical-clavate, 40-50μ × 4-5μ, scarcely attenuated at the base, the apex not colouring blue with iodine; spores oblong-fusiform, hyaline, smooth, non-septate, often slightly curved, 7-8μ × 2μ, guttulate and granulose, three of the guttulae being large, the granules much smaller.

On clay, Silchester, Hants, April, 1914.

This interesting fungus was collected by Mr. D. Garnett amongst moss under *Ulex* when searching for young stages of *Discinella Menziesii.* (*Vide* Journ. Bot. l.c.)

SPHAEROPSIDEAE.

PHYLLOSTICTA VALERIANAE n. sp.

Maculis epiphyllis indeterminatis, irregularibus, 4-5 mm. latis, colore aurantiaco cinctis; pycnidiis epiphyllis, paucis, immersis, globosis vel lenticularibus, parum depressis, epidermide tectis, dein apiculo subconico erumpentibus, 150-200μ diam., membranaceis, brunneis; sporulis rectis v. curvulis, utrinque rotundatis, apicibus saepe lenissime incrassatis, obtusisque, hyalinis 8-10μ × 2-3μ.

In foliis *Valerianae officinalis.*

Coll. D. A. Boyd, Glen Easdale, Whiting Bay, August, 1913.

ASCOCHYTA MIMULI n. sp.

Maculis epiphyllis, ovalibus, ca. 1 cm. latis, flavidis, obscurius marginatis et concentrice zonatis; pycnidiis subcutaneis, erumpentibus, brunneis, poro pertusis, globosis, 110-120μ diam., contextu parenchymatico; sporulis oblongis, utrinque rotundatis, rectis curvulisve, guttulatis, 1-septatis, 10-14μ × 2-3μ, hyalinis.

In foliis *Mimuli Langsdorfii.*

Coll. D. A. Boyd, Dalry, August, 1913.

A. GALEOPSIDIS n. sp.

Maculis varieformibus, amphigenis, primum brunneis dein pallescentibus, brunneo vel atropurpureo-marginatis; pycnidiis 100-150μ diam., epiphyllis, confertis, epidermide velatis, poro

pertusis, pallide brunneo; sporulis cylindraceo-bacillaribus, medio septatis, rectis vel subcurvulis, hyalinis, 9-11μ × 2-3μ.

In foliis *Galeopsidis Tetrahitis*.

Coll. D. A. Boyd, Machie Bay, Arran, August, 1913.

A. URTICAE *n. sp.*

Maculis amphigenis, subrotundatis, ochraceo-brunneis, e medio arescentibus, margine angusto nigro-bruneo cinctis; pycnidiis epiphyllis, sparsis, immersis, epidermide tectis, poro (c. 20μ late) pertusis, 120-150μ diam.; sporulis 10-12μ × 2-4μ, forma irregularibus, ± oblongis, hyalinis, uniseptatis, ad septum constrictis.

In foliis *Urticae dioicae*.

Coll. D. A. Boyd, Colintraive, Aug. 1913.

Diplodina Sonchi Henn. in Hedw. XLV., p. 32 (1905).

Pycnidia caulicolous, piercing the epidermis, hemispherical or subglobose, black, protruding in the centre, 100-120μ in diam.; spores oblong-cylindrical, straight or curved, biguttulate then with a median septum, hyaline, 8-13μ × 3-3·5μ.

On the dried stems of *Sonchus asper*.

A fungus gathered by Mr. D. A. Boyd on the leaves of *Sonchus arvensis*, at Colintraive, Argyllshire, Aug., 1913, agrees with this description, the only additional point being that the pycnidia sometimes attain a diameter of 180-200μ. The wall of the pycnidium is non-parenchymatous and the fungus is therefore better placed in *Diplodina* than in *Ascochyta*, since the distinction made by some authors that the former occurs on all parts of the plant except leaves, whereas the latter is purely foliicolous cannot here be applied.

Septoria Scorodoniae Passer. in litt. Sacc. Miscell. Myc. No. 2243. Sacc. Syll. III., p. 540 (1884).

Spots small, subcircular, chiefly on the upper surface, finally perforating the leaf, reddish-ochraceous; pycnidia few, punctiform-lenticular, 80μ diam., piercing the epidermis; spores bacciliform, with obtuse ends, non-septate, hyaline, eguttulate, 36μ × c. 1μ.

On fading leaves of *Teucrium Scorodonia*.

Coll. D. A. Boyd, Loch Ard, Perthshire, July, 1914.

Septoria Scutellariae Thüm. Pilzf. Sibir. Nos. 630 & 631. Sacc. Syll. III., p. 539 (1884).

Spots on both sides of the leaf, small, sinuate, brown, soon withering and becoming whitish, surrounded by a well-marked dark reddish-brown border. Pycnidia on the upper surface,

covered, the epidermis being pierced only by the 25μ wide, scarcely darker coloured pore, light brown, 100-150μ in diameter. Spores filiform, usually bent or flexuose, almost pointed at the ends, occasionally with three indistinct septa, 45-60μ × 1-1·5μ.

On leaves of *Scutularia galericulata.*

Coll. D. A. Boyd, Colintraive, Aug., 1913.

S. Bellidis Desm. et Rob. 21 Not., p. 6 (1853). Sacc. Syll. III., p. 548 (1884).

Spots olive coloured, then becoming dry and an earthy yellowish-brown, roundish or irregular in shape. Pycnidia on both sides of the leaf, remaining covered by the epidermis which is pierced only by the ostiole, brown, not darker at the pore, 50-70μ diam. Spores filiform, straight or slightly waved, becoming somewhat pointed towards the ends, with indistinct oil drops, 30-40μ × 1-1·5μ.

On leaves of *Bellis perennis.*

Coll. D. A. Boyd, Dalry, Aug., 1913.

Septoria Senecionis silvatici Syd. in Hedw. XXXVIII., p. 139 (1899).

Spots occurring on both sides of the leaf, pale brown, roundish oblong. Pycnidia on the upper surface, light brown, covered, only the pore, which is of the same colour, boring through the epidermis, 70-90μ in diameter, the pore 20-25μ wide. Spores filiform, somewhat narrowed at both ends, straight or flexuose, with a few indistinct septa, 30-50μ × 1·5μ.

On leaf of *Senecio silvaticus.*

On leaf of *Senecio Jacobaea*, Colintraive, Argyllshire, Aug., 1913. Coll. D. A. Boyd.

The fungus has previously been recorded only on *S. silvaticus.* A protest is called for against the method of nomenclature which is often applied to the Uredineae being extended to the Fungi Imperfecti as in the name of this species. In the former case, owing to specialization, there is possibly some slight excuse for it: in the latter there is, at present, none whatever.

STAGONOSPORA BROMI n. sp.

Maculis amphigenis, elongatis, saepe confluentibus, purpureo-brunneis dein intus pallescentibus; pycnidiis atris, e globoso horizontaliter oblongis, 150-175μ diam., contextu parenchymatico; sporulis fusiformibus, rectis vel curvulis, 3-septatis, non constrictis, 17-24μ × 3μ.

In foliis languescentibus *Bromi ramosi.*

Coll. D. A. Boyd, Dalry, Aug., 1913.

S. HERACLEI n. sp.

Maculis varieformibus, immarginatis, sordide brunneis, expallescentibus; pycnidiis globosis, primo epidermide tectis dein erumpentibus vel denudatis, atris, contextu non-parenchymatico; sporulis oblongis, rectis, primo guttulatis, 1-2-septatis, ad septa leniter constrictis, 14-20μ × 4-5μ, hyalinis.

In folio languente *Heraclei Sphondylii.*

Coll. D. A. Boyd, Dalry, Aug., 1913.

In certain of the preparations of this species triseptate elliptical spores c. 17 × 3μ were also present. The place of origin of these spores could not be traced.

Coniothyrium Ribis Brun., Champ. Saint. p. 338. Sacc. Syll. X., p. 263.

Pycnidia ± gregarious, erumpent, spherical, black; spores oblong, eguttulate, brown, 8-10μ × 3-3·5μ.

On branches of *Ribes Grossularia.*

This species, which is very closely allied to, if not identical with, *C. olivaceum,* was communicated from the "Gardeners' Magazine" (J. K. Ramsbottom).

HYPHOMYCETES.

PENICILLIUM.

During the last few years many investigators (Dierckx, Bainier, Thom, Westling, etc.) have made intensive studies of the genus *Penicillium.* The old species have been split up chiefly on cultural grounds. Westling, for example, recognises fifty-eight species of green *Penicillium.* Miss Dale has found the following, named by Thom, as well as several others which are not definitely named.

P. biforme Thom. Cultural Studies of Species of Penicillium, U.S. Depart. of Agric., Bureau of Animal Industry, Bull. 118, p. 54 (1910).

Cultivated in gelatine, white, slowly gray-green, densely floccose, with broad vegetative margin, spreading widely over the substratum; in potato agar white, then gray-green, rapidly becoming yellowish-brown, drab, or almost olive, restricted in growth, aerial portion consisting of very short densely crowded conidiophores and conidial fructifications; conidiophores 60-150μ on agar or slightly longer when arising as branches from the floccose aerial mycelium growing upon gelatine; conidial fructifications mostly once or twice alternately branched, branches convergent or divergent, each bearing a verticil of branchlets crowned by verticils of conidiiferous cells with chains of conidia, the whole 60-240μ, usually 100-200μ, in

length; conidiiferous cells 8-10 or even 13 × 3μ; conidia elliptical or cylindrical, then globose, 3·2-3·5μ × 4-4·3μ or 4μ in diameter, adhering in chains in fluid mounts; grows luxuriantly in fluid offering milk-sugar as source of carbon, partially and slowly liquefies gelatine, with alkaline reaction to litmus; odour, very strong, "mouldy," characteristic.

Originally found on cheese from France.

It is closely related by cultural characters as well as morphology to *P. camemberti*, with which it shares the ability to grow normally in fluid offering lactose as a source of carbon, but differs in its short conidiophores, diverse habit upon potato agar and gelatine, and its strong characteristic smell.

In cultures from sandy soil, Woburn, E. Dale, tom. cit., p. 39.

P. rugulosum Thom, tom. cit. p. 60.

Cultivated in gelatine or bean agar, yellowish-green, then green, at length dark green; surface growth of densely crowded conidiophores with few aerial hyphae interspersed at their bases; reverse of colonies yellow to orange in spots, especially upon potato or upon sugar media; substratum not or slightly yellowed; conidiophores 100-200 by 2·5-3μ, arising separately or branching from aerial hyphae just above the substratum; conidial fructifications 100-150μ in length, consisting of appressed, verticillate branches 10-15 × 2·5μ, bearing verticils of conidiiferous cells, of branchlets, or of conidiiferous cells and branchlets together; conidiiferous cells 9-12 × 2μ, acuminate, bearing long divergent chains of conidia; conidia 3·4-3·8 × 2·5-3μ, elliptical, green, mostly with swelling at one end, verruculose when ripe, swelling to 5μ and germinating by one or two tubes; colonies do not or only partially liquefy gelatine.

Common in cultures.

Characterized by its verrucose spores and the brilliant colour of the mycelium viewed from below.

In cultures from sandy soil, Woburn, E. Dale, tom. cit. p. 40.

P. stoloniferum Thom, tom. cit. p. 69.

Cultivated in gelatine or potato agar, green or yellowish-green, becoming gray-green or gray when old (remaining green in sugar media), floccose, spreading more rapidly in young cultures by aerial stolons than by submerged hyphae (i.e., the submerged mycelium seems to arise from the aerial rather than vice versa); reverse of colony not coloured or partly yellow; conidiophores arising as short branches (100μ or less in length) from aerial hyphae, or arising separately, 300μ or more in length, especially at the margins of older colonies; conidial fructification 40-80 more rarely up to 170μ in length, com-

posed of short appressed branches and numerous conidiiferous cells densely crowded at the base bearing very loosely divergent chains of conidia; sometimes the lowest branch diverges so that the fructification appears double; conidiiferous cells $10 \times 3\mu$; conidia slightly elliptical or globose, $2{\cdot}8 \times 3{\cdot}4\mu$, smooth, yellowish green in mass, almost hyaline by transmitted light; colonies liquefy gelatine very rapidly, with a strong alkaline reaction to litmus.

On decaying *Boleti*, *Polypori*, etc.; cultures from milk and ensilage.

The stolon-producing character is so easily seen and so characteristic of this species as to seem adequate to distinguish it.

In cultures from peat, E. Dale, tom. cit., p. 52.

P. lilacinum Thom, tom. cit. p. 74.

Cultivated in pure gelatine or bean agar white, white to pale lilac in cultures containing sugars, ± loosely floccose with hyphae branched, septate, ascending, 3μ in diameter, producing conidial masses upon very short branches irregularly distributed, or becoming conidiophores toward the apex; reverse of colony not discoloured; conidial fructifications up to 100μ in length, consisting of solitary, sessile, conidiiferous cells, or verticils of conidiiferous cells, or short branches bearing 1, 2, or 3 verticils of branchlets and conidiiferous cells with long, tangled chains of conidia. Conidiiferous cells flask-shaped, divergent at the apices, acuminate, 7-10μ in length; conidia elliptical, smooth, $2{\cdot}5$-$3 \times 2\mu$, thin walled, pale lilac. Colonies slowly liquefy gelatine, with strong alkaline reaction.

A relationship of this species to the common green forms is very doubtful. The chains of conidia produced break up so quickly and completely in mounting in fluid for examination that it is often difficult to find even a single conidium attached to its sterigma. The form of conidial fructification varies from a single conidiiferous cell or basidium with a chain of conidia upon an aerial hypha to a single verticil, or a branch with two or three successive verticils and even to a terminal fructification allying it with the typical penicillate forms.

In cultures from chalk soil, E. Dale, tom. cit. p. 43.

P. Constanti Bainier, in Bull. Soc. Mycol. Fr. XXII., p. 205 (1906). *Synpenicillium album* Cost. Bull. Soc. Mycol. Fr. IV., p. 67 (1888).

Mycelium abundant, white, creeping, sparingly septate, emitting crowded conidiophores above; conidiophores cylindrical, septate, here and there, at short intervals, with steep

branches, occasionally laxly subfasciculate, at the apex verticillately branched, the ultimate branchlets phialiform; conidia in rather long chains, terete-ovoid, 6-13μ × 3-6μ, rounded, smooth, hyaline.

In excrementa, straw, decaying paper, &c.

In cultures of soil from reclaimed fen land, E. Dale, tom. cit. p. 57.

"It seems to me, however, from its behaviour in culture as well as from its morphological characters to belong to Bainier's genus *Scopulariopsis*. In culture it is at first white, then cream-coloured or pale cinnamon or café au lait. It liquefies gelatine slowly, with the development of a strong ammoniacal odour."

P. lividum Westling in Arkiv f. Bot. II., p. 134 (1911).

Cultivated in prune gelatine floccose, white, then slightly greenish—or greyish—caeruleous, not liquefying gelatine; with a wide sterile margin; reverse of colony colourless or somewhat yellowish; conidiophores arising from the submerged hyphae, smooth, simple (not penicillately branched), 2·2-3·5μ wide, up to 450μ long; sterigmata 2-2·4μ × 9-12μ; conidia elliptical or ovate, smooth or almost smooth, 2·2-2·6μ × 2·7-3μ.

In cultures from peat, E. Dale, tom. cit. p. 52.

SCOPULARIOPSIS Bainier, Bull. Soc. Mycol. Fr. XXIII., p. 98 (1907).

This genus was founded by Bainier for certain fungi which greatly resemble species of *Monilia*, but in which the conidia are cut off one below the other by the sterigmata, while in *Monilia* the filaments become septate, then dissociate into segments, thus forming the spores. The conidiiferous filaments are similar to those of *Penicillium*, but have always a very short support and are irregular. Branches generally large, membrane delicate and easily drying up; sterigmata much elongated; conidia voluminous, round or oval, smooth or echinulate, some of ± triangular shape being usually present; colour always bright; developing on decaying substances.

S. PENICILLIOIDES nov. comb. *Monilia penicillioides* Delacroix Bull. Soc. Myc. Fr. XIII., p. 114 (1897), *M. Koningi* Oud.

This species was described as *Monilia Koningi* in Miss Dale's previous paper. A culture was submitted to us, and this was our determination. She points out in her present paper that the species is doubtless *Monilia penicillioides* Delacr., and places it in the genus *Scopulariopsis*. With this we agree but not with the additional synonomy.

S. repens Bain., Bull. Soc. Mycol. Fr. XXIII., p. 125 (1907). *Penicillium Bainieri* Sacc.

Sterile hyphae creeping, with few septa; conidiophores very short, soon twice verticillately branched; ultimate branches (pseudosterigmata) obclavate-phialiform, 14-28μ long; conidia spherical or elliptical in somewhat long chains, smooth or echinulate, ± café au lait, 6-8μ diam.

In cultures from chalky soil, E. Dale, tom. cit. p. 46.

"In culture it is at first white, then cream-coloured, and finally a deep chocolate brown. On carrot an old culture becomes nearly black."

S. communis Bain., l.c., *Penicillium Scopulariopsis* Sacc. non. *P. commune* Thom.

Sterile hyphae creeping, frequently fasciculate, with few septa, hyaline; conidiophores crowded, very short, for the most part continuous, at the apex once, rarely repeatedly verticillately branched, ultimate branches (pseudosterigmata) ± elongate-obclavate; conidia ovoid or spindle-shaped and truncate at the lower extremity, hyaline, 6-11μ × 3·6μ, in rather long chains.

In cultures from chalky soil, E. Dale, tom. cit. p. 46.

"The conidiophores are short lateral branches which are at first solitary and bear each a single conidiiferous cell. Later other conidiiferous cells are formed or the conidiophore may bear short metulae producing conidiiferous cells, until a dense mass is formed. The conidia . . . are rather thick-walled, and cream or tawny coloured."

SYNSPORIUM Preuss in Linnaea XXIV., p. 121 (1851).

Sterile hyphae creeping. Conidiophores in tufts, upright, septate, branched. Conidia oblong, borne in a terminal head on the conidiophore, brown, continuous. The genus differs from *Acrotheca* in its branched conidiophores.

S. biguttatum Preuss. l.c.

Mycelium effuse, first dark, then coal-black. Conidiophores creeping, then ascending, branched, brown. Conidia large, oblong-ovoid, passing from hyaline to blackish-brown, usually with an oil drop at each end.

In cultures from chalky soil, E. Dale, tom. cit. p. 46.

"The conidiophore, which is septate, swells at the end into an oval head; on this are formed, in succession, the sterigmata, from which bud out the spores, first as almost spherical and then as cylindrical outgrowths. Apparently only one spore is formed on each sterigma, but fresh sterigmata are produced until a globular head of spores is formed."

CERCOSPORELLA Sacc. Michelia II., p. 20 (1880), Syll. IV., p. 218.

Mycelium entophytic forming spots. Conidiophores mostly tufted or heaped together, usually unbranched and continuous, occasionally branched or septate, often with small teeth-like processes above, hyaline. Conidia cylindrical or elongate-filiform, pointed or obtuse, sometimes also inverted club-shaped and drawn out into a long point, multiseptate, hyaline.

Analogous to the genus *Cercospora* in the Dematieae.

C. Virgaureae (Thüm) Allescher in Hedw. XXXIV., p. 286 (1895). *Cercospora Virgaureae* Thüm.

Spots irregular, angular, pallid, yellow on the upper surface, then brownish. Tufts mostly spread over the lower surface. Conidiophores tufted or heaped, often having small teeth at the tips, 30-80μ long, hyaline. Conidia cylindrical, then elongated, diminished above, 30-80$\mu \times$ 3-5μ, hyaline, 6-septate.

On living leaves of *Solidago Virgaurea*.

Coll. D. A. Boyd, Colintraive, Argyllshire, Aug., 1913.

Ramularia nymphaearum (Allesch.) Ramsb. in Journ. Roy. Hort. Soc. XL., p. CXV. (1914). *Gloeosporium nymphaearum* Allesch. in Hedw. XXXIV., p. 276 (1895), *Ovularia nymphaearum* Allesch. in Rabenh. Krypt. Fl. Pilze VII., p. 510 (1901), *Ramularia Nymphaeae* Bresad. in Syd. Myc. march. no. 4077 (1896), *Ovularia Nymphaeae* Bresad. in Fung. Eur. no. 4292 etc.

Spots on both sides of the leaf, at first roundish with concentric zoning, afterwards enlarging irregularly, passing from a somewhat reddish colour to a greyish-brown or black and finally rupturing in the centre. Mycelium superficial, white, loose at first but later forming compact white spots. Conidiophores single, straight, upright, aseptate, about the same length as the conidia, hyaline. Conidia single, acrogenous, oblong or cylindrical, sometimes somewhat club shaped, rounded at both ends, hyaline, 15-20$\mu \times$ 3·5-4·5μ, often up to 28$\mu \times$ 6μ, without oildrops.

On the floating, living leaves of *Nymphaea* spp. and *Nuphar* spp.

In the young stages tufts of conidiophores can be seen projecting from neighbouring stomata. Eventually by the rapid growth of the fungus the epidermis is ruptured and gives the appearance of a *Gloeosporium*.

In the specimens examined the spores became septate at maturity.

On leaf of cultivated *Nymphaea*, Mr. E. A. Bowles, May, 1914; on floating leaves of yellow water lilies, Wicken Fen, Cambridge, October, 1913.

R. Cardamines Syd. in Ann. Mycol. I., p. 538 (1903).

Spots on both sides of the leaf, roundish or irregular, often very much spread out at the margin, brownish-green, mostly bordered by a yellowish irregular streak, sometimes somewhat distended. Tufts on the under surface, very small, greyish-white. Conidiophores arising in small clusters out of the stomata, branched, few in number, septate, at first upright, hyaline, 30-50μ × 3-3·5μ. Conidia cylindrical, seldom ellipsoid, rounded at both ends or pointed, usually quite straight, continuous or mostly uniseptate, seldom 3-4-celled, in chains, hyaline, 22-35μ × 2·5-3·5μ.

On living or decaying leaves of *Cardamine amara.*

Coll. D. A. Boyd, Dalry, Ayrshire, Aug., 1913, and Dalserf, Lanarkshire, June, 1914.

R. Schulzeri Bäuml. in Verh. zool. bot. Ges. Wien, L., p. 716 (1888).

Spots indeterminate, scattered, yellowish brown then reddish or almost white. Tufts gregarious, white. Conidiophores very tufted, projecting from the stomata, arising from a small cushion-shaped stroma, unbranched or sparingly branched, hyaline, 20-40μ (mostly up to 30μ) × 2-4μ. Conidia single or in short chains, cylindrical, tapering towards the ends, continuous or seldom uniseptate, hyaline, 8-20μ × 3-4μ.

On living leaves of *Lotus corniculatus.*

Coll. D. A. Boyd, Kilwinning, Ayrshire, Aug., 1913, on leaves of *L. uliginosus.*

Sydow (Myc. march. 3079) gives *L. uliginosus* as a host for this fungus, but Lindau in Rabenhorst's Krypt. Flora VIII., p. 462, queries this.

Ramularia Angelicae v. Höhn. in Hedw. XLII., p. 178 (1903).

Spots small, numerous, angular, often indistinct, the larger spots whitish towards the middle and brownish on the outside: tufts on both sides of the leaves, scarcely visible, almost always bursting through the epidermis: conidiophores tufted, of different lengths, very narrow, with few septa; conidia bacilliform, continuous or with one or two septa, 20-30μ × 1·5-2·5 (rarely up to 3) μ.

On the leaves of *Angelica sylvestris.*

Coll. D. A. Boyd, Glen Easdale, Whiting Bay, Arran, Aug., 1913.

MONOTOSPORA AFFINIS n. sp.

Effusa, velutina, nigra; hyphis sterilibus repentibus; hyphis fertilibus simplicibus, rectis, septatis, brunneis, apice pallidiori-

bus rotundatisque, 110-150μ × 5-8μ, basi dilatatis sursum sensim attenuatis; conidiis acrogenis, solitariis atro-brunneis, maturitate vacuolo instructis, obampulliformibus, 25-30μ × 20μ.

In ligno putrido.

Coll. D. A. Boyd, Killermont, Dumbartonshire, Oct., 1914.

This specis is apparently most closely allied to *M. pumila* (Mass.) Sacc., but the spores of the latter are somewhat shorter and of different shape judging by the published figures.

TRIPOSPORIUM BOYDII n. sp.

Caespitulis latis, atris; hyphis erectis, simplicibus, septatis, atro-fuscis, 50-70μ × 4μ, apice conidium solitarium gerentibus; conidiis 3- (raro 4-) radiatis, ad mediam partem atro fuscis, versus extremitates gradatim pallidioribus; radiis 6-8-septatis, 25-45μ × 7-12μ.

In ligno putrido.

Coll. D. A. Boyd, Killermont, Dumbartonshire, Oct., 1914, and West Kilbride, Ayrshire, Feb., 1915.

HELICOSPORIUM BOYDII n. sp.

Caespitulis effusis, velutinis, atris; hyphis sterilibus repentibus; hyphis fertilibus erectis, septatis, fuligineis, sursum pallidioribus, 90-110μ × 3μ, lateraliter conidigeris; conidiis 18-20μ latis, in spiram helicoideam $\pm$ simplicem duplicemve, cellularem ad 6μ crassam convolutis, hyalinis dein dilute fuligineis, 8-12-septatis, non-constrictis; cellulis maturitate vacuolo instructis.

Ad lignum putridum.

Coll. D. A. Boyd, West Kilbride, Ayrshire, Feb., 1915.

DICTYOSPORIUM BOYDII n. sp.

Effusum, atrum; conidiis applanatis, hyalinis dein fuscis, varieformibus, supra acutis vel rotundatis, basi obtusis vel cordatis, 36-48μ × 20-28μ, cellulis 4-6μ diam., in 5-6 seriebus leviter spiraliterque contortis, non secedentibus.

Ad lignum putridum.

Coll. D. A. Boyd, Killermont, Dumbartonshire, Oct., 1914.

MORDECAI CUBITT COOKE.

(1825-1914.)

By J. Ramsbottom, M.A.†

Mordecai Cubitt Cooke was born at Horning, Norfolk, on July 12th, 1825. His father, Mordecai Cooke, had been a middleman in the bombasine trade, but when the manufacture of this material declined he started a shop (now the village post-office), which, being the only one in the district, dealt in everything needed by a rural population. "This was the domestic era of the tinder box and rushlight, and before the first boxes of 'Lucifers' astonished the natives at the cost of twopence halfpenny each."* He was a strong Calvinist and frequently conducted prayer meetings. His wife, Mary Cubitt, was the daughter of the master of a school at the neighbouring village of Neatishead. Cooke's christian names have always been a matter of interest, and that he himself perhaps felt a little strongly on the subject is seen from the preface to his first book "The Seven Sisters of Sleep." Mordecai is a family name, and there is a tradition that some time in the 15th century the Cooke of that day married a Jewess who gave her children the names Mordecai and Rebecca: in any case the names can be traced back to the middle of the 17th century. As a child Cooke contracted smallpox, which left him temporarily blind, and until the age of twelve he had much trouble with his eyes. His first school was a dame's school, which he attended until he was nine years of age; the dame was assisted by a niece who was an excellent penwoman, and it was to her tuition that Cooke owed the bold flowing hand so familiar to mycologists. In this connection it is a matter of surprise that Cooke wrote exceedingly rapidly, laying the sheets in front of him to dry while still writing, making few alterations, and doing remarkably little editing. It was to his mother that Cooke owed his introduction to botany, for as a child he collected flowers with her in the Norfolk lanes. His earliest book was Culpepper, which probably belonged to her, as it is

† A shortened form of this obituary notice appeared in the Journal of Botany, Vol. 53, p. 58 (1915).

* Essex Naturalist X., p. 216 (1897).

inscribed "M. Cook. 1827." In 1834 he left the dame's school and was sent to Ilford (on the top of a stage coach) to be educated by his uncle, the Rev. James Cubitt, a dissenting minister, who afterwards became classical tutor at Spurgeon's College. "I was with my uncle for two years, and during that time was laid the foundation of every quality I was able to display in the way of work in after life. My uncle grounded me well in the rudiments of Latin, Greek, Algebra, etc., and he even made my daily walks contributary to the acquisition of useful knowledge, for he used to send me down the Barking road with instructions to make collections of plants and flowers that grew by the wayside and to name them afterwards with such assistance as I could get from him or his little botanical library."* In a presidential address to the Hackney Microscopical and Natural History Society in 1887 Cooke referred to this period: "This Jubilee year of Her Majesty's reign reminds me that I began the study of Botany before that reign commenced. . . . I cannot say that I proceeded very far in the study of plants during the reign of William IV., but I was in the habit of going periodically into the lanes and fields to collect flowers, and on my return home, did my best, by pulling them in pieces, with Macgillivray's edition of Withering's Botany before me, as my only guide, to discover their names and places. It was dry work in those days, and all the methods were of the driest and most mechanical." Pinnock's Catechism was almost the only other book within reach of poor country students, and a clergyman's daughter who could "run down" a hundred plants from Withering gained quite a local reputation. It would seem that Cooke remained with his uncle four years, as they removed to Stratford-on-Avon and he there remembered witnessing the proclamation of the accession of Queen Victoria. Shortly afterwards Cubitt married, and in 1838 Cooke returned to Norfolk and was sent along with his brother, who still lives, to a school at Neatishead, kept by one William Moore. His education here was peculiar. He already knew all that Moore found it necessary to teach his pupils. Moore, however, in addition to pedagogy did land surveying, and Cooke accompanied him, helped with the practical part of the work, and then worked out the results during school hours. Moore, moreover, kept the Rates book for the overseers of the parish, and his useful pupil was permitted to assist further in working out the rates.

At the age of fifteen Cooke was apprenticed to a wholesale linen and drapery establishment at Norwich. The drapery business apparently suited him but little, the only pleasure he

* *Morning Post,* July 13th, 1912.

seemed to get out of his existence was by learning to play on wind instruments, on most of which he became more or less proficient. At the age of twenty he left Norfolk and returned to London to live with a second uncle, William Cubitt, a keen Baptist and one of the compilers of the Baptist Year Book, by trade a manufacturer of sealette, velvet and coach trimmings. Cooke found occupation as a copying clerk in a solicitor's office, but in 1847 had a serious attack of gastritis and lost his situation. About this time he had begun to blossom out as a poet, for we find him publishing, at 4½d. each, verse with such titles as "The Struggle for Freedom," "Flight of Thought," "Course of Love," etc. He seems to have tried his hand as a lawyer's clerk in the bankruptcy court, as an usher in a school at Birmingham, and as a lecturer on poets and poetry. About this time came Cooke's introduction to fungi. "It was my good fortune to be introduced to an East Anglian gentleman,* who resided in a small agricultural village not ten miles from Norwich. I had been invited to give a gossiping lecture to the rustics in the schoolroom, and was asked to take a preliminary tea with the squire. It soon became manifest that the hobby of my host was 'edible fungi,' a subject of which I was then profoundly ignorant, but I became greatly interested in the discovery that there were other fungi beside the mushroom which might be eaten, and I had the pleasure of looking over his portfolio of coloured drawings, and hearing his explanations and encomiums. This was my first inspiration to turn my attention to 'toad-stools.' I had never seen them before, or at least with an appreciative eye, and the subject came upon me as a revelation. At first I did, as so many others have done, restricted my interest to their edible qualities, and had no ambition beyond being able to recognize, collect, and devour some half-dozen different kinds of 'toad-stools,' which, in all my surroundings, I had been taught to regard as 'rank pi'sen.' Since that eventful evening I have never abandoned the pursuit, and it has been my solace."†

In 1849 we find Cooke editing "The Monthly Repository of General Literature," though it may be added that he wrote practically the whole of this short-lived periodical under various names or permutation and combinations of his initials. At the end of this year he accepted an invitation from an aunt and uncle at Stockton-on-Tees to make himself acquainted with the Pestalozzian system of educating infants. He remained at the school for three months and then successfully replied to an advertisement for a master to open the new Trinity School, Lambeth, under

* Richard Ward, Salhouse Hall.
† Grevillea XIX., p. 68 (1891).

the old National School system. Cooke now settled down, and applied himself with his customary vigour to his occupation. In addition to his ordinary teaching he held evening classes on all kinds of subjects and wrote for educational journals on practically everything. In connection with the school he began a museum of economic products and conducted a similar museum for the Metropolitan Scholastic Association of elementary teachers: he also gave lessons on economic botany, led thereto principally by the writings of Peter Lunn Simmonds, author of *Commercial Products of Vegetable Kingdom*. One branch of this study related to Indian food products, of which he acquired a fairly good general knowledge. He used to visit brokers in Mark Lane and Mincing Lane for the purpose of obtaining samples of any new or interesting products which came into the market. He entered as a student in the Science and Art Department at South Kensington, where he studied various subjects, including structural and systematic botany and drawing. About this time he made a fine series of water colour studies of birds. Subsequently he conducted botanical classes under the Science and Art Department of which he was the first certificated teacher under the Minutes.

In 1860 another clergyman was appointed to Trinity Church who considered Cooke's evening lectures on various subjects unnecessary and his botanical activities mere waste of time. In consequence Cooke resigned his post, and sold his museum for £100. This same year he published his first volume, *The Seven Sisters of Sleep*, a popular history of the prevailing narcotics of the world, a theme suggested by his collections. About this time he was connected with Twining's Economic Museum, Twickenham, and also gave botanical lectures in the gardens of Holly Lodge, Highgate, to the gardeners and others in the employ of Baroness Burdett-Coutts, and at the Working Men's College.

After leaving Lambeth, Cooke shared rooms with P. L. Simmonds, for whom he wrote in the *Technologist*. In 1861 he was, on the recommendation of Simmonds, employed to compile the catalogue of the Indian exhibits at the second great English Exhibition of 1862. Here he got to know Dr. Forbes Watson, chief of the India Museum, and, after completing a similar work for the commissioners, he was taken over as a sort of handy man at the Museum, Fife House, Whitehall, where he arranged and stored the raw products of India. He remained until the Museum was abolished in 1880.

When conducting his botanical classes in the late fifties, Cooke sometimes took his pupils for country rambles in order to give them practical demonstrations on wild flowers. Subse-

quently some of these old pupils, who were joined by outsiders, constituted themselves into a small society. This, "The Society of Amateur Botanists," was founded in 1862. It was "established for mutual assistance in the study of British Plants, by organised Excursions into the country—the interchange of Specimens—the communication of Papers—and the establishment of a Library, Herbarium, and Museum, or such other means as may from time to time be deemed expedient." Cooke was the first and only president. Excursions were held during the summer on alternate Saturday afternoons, and fortnightly meetings on Wednesday evenings. The excursions were the chief attraction "for collecting plants, and for a cosy tea afterwards." "It was while engaged in these excursions that I first became interested in fungus parasites." According to Mr. W. G. Smith,* "Dr. Cooke at that time had noticed the fungi but little; he collected and studied the microfungi and was very keen on all animate subjects. He captured toads, frogs, newts and snakes." To add to the picture—"Dr. Cooke was an inveterate smoker, and when he was not pulling at his pipe he was singing." The Society attracted other botanists and at one time numbered about fifty members. Some of the papers read at the meetings were published in the *Journal of Botany* or in the ephemeral *Botanist's Chronicle*. Among the better known botanists who were members, or attended some of the meetings, were Messrs. J. Britten, W. T. T. Dyer, W. W. Newbould, B. Seeman, W. G. Smith, and H. Trimen. The meetings were first held at the Metropolitan Club in Euston Road, but afterwards in the room over Robert Hardwicke's shop in Piccadilly. W. G. Smith engraved a brass plate "Society of Amateur Botanists," which was placed on the side of Hardwicke's door. About this time Hardwicke was a successful publisher of Natural History books, *e.g.*, the third edition of *English Botany*, with Boswell Syme as editor and with Mrs. Edwin Lankester as responsible for the popular notes. He was also publishing the *Popular Science Review*. Dr. Edwin Lankester introduced Cooke to Hardwicke. "As contributor to the pages of the *Popular Science Review* and as a writer of popular books on Natural History, of which Mr. Hardwicke was the publisher, I was in close business relations with Mr. Hardwicke. . . . At length I suggested to Mr. Hardwicke and to Mr. Ketteringham [his manager] that there was a good opening for a cheap monthly magazine, which should be devoted to Natural History and Microscopy, offering facilities for exchanges and copious notes and queries. This idea was eagerly entertained, and *Hardwicke's Science Gossip* was the title suggested by Mr. Hardwicke, and to this he adhered

* Gard. Chron. p. 356 (1914, II.).

pertinaciously. At length the scheme took form, and I was selected to model and afterwards act as Editor of the new Journal. The first number appeared January 1st, 1865, and became at once a success. At that time there was no competitor, and for a long time it was the only cheap Journal of Natural History."* It is interesting to note that Cooke favoured the more poetical title of *Veil of Isis* for the new magazine, and the symbol of the goddess appeared at the end of the preface. Cooke's versatility here found full scope, and the paper achieved a "decided success even beyond our most sanguine hopes when we first planned its constitution." In the May issue of the first volume there appeared a letter from W. Gibson suggesting the formation of an association of amateur microscopists which would be of greater service to them than the older and more pretentious Royal Microscopical Society, something "on the plan of the Society of Amateur Botanists." The Editor added a note: "We insert our correspondent's communication, and would be glad to hear from any microscopists desirous of co-operating with him in carrying out his proposals," and solicited communications on the subject. The suggestion fell on fertile ground. Two of the members of the Amateur Botanists were T. Ketteringham and W. M. Bywater, who was manager of a saddlery business house in Hanover Square. Both were keen microscopists and rather musical. They used to meet once a week and Cooke was introduced to the meetings by Ketteringham. Over the shop in Hanover Square the three, for the first hour or so, talked microscopy, and from ten to eleven discussed cigars, sandwiches, liquid refreshment and science gossip. After the publication of Gibson's letter, he was invited to one of the meetings, and "all of us resolved to make a strong effort for the establishment of such a society as that proposed." Hardwicke, though not a microscopist, did all he could by placing his office at their disposal for preliminary meetings and allowing it to be used as a provisional office for correspondence. After several meetings, at which Cooke was chairman, the "Quekett Microscopical Club" was formed. Cooke was asked to be the first president, but declined in the event of the committee being able to secure the services of Dr. Edwin Lankester (which they did) or someone of equal repute or influence. Cooke was one of the two vice-presidents during the first year, and Hardwicke treasurer and secretary. The first paper in the first volume of the journal of the club is by Cooke, "On Universal Microscopic Admeasurement." He pointed out the advisability of the universal adoption of the French metric system for microscopic measurement instead of the various systems then in

* Journ. Quekett Micros. Club, ser. 2 VII., p. 229 (1899).

vogue. Convinced by his sensible arguments, this young society adopted his suggestion and appointed him Honorary Secretary for Foreign Correspondence, to the end that he might correspond by circular with the other then known microscopical societies. Cooke deserves the gratitude of every user of the microscope in this county for his successful efforts. The Quekett admitted 155 members during its first year. The excursions of the Society of Amateur Botanists—"the only instance, at that period of time in which any periodical excursions were made by any society in or around London"—were copied. Many of the Amateur Botanists joined the club "and always declared that the newer and larger society with a wider programme had extinguished them."

During this period Cooke was energetic in other directions. While working for his Science and Art examinations he "realised the need for some simple text book on botany for students," and this led him to write his *Manual of Structural Botany*, a small shilling book which was published in 1861 and was a great success and passed through numerous editions. In the following year a *Manual of Botanic Terms* was published. The preface tells us that "the Terms are written in their Anglicised forms, under which they are commonly employed; and the derivations are recovered from the mysticism of a Greek alphabet. Both these innovations, it is confidently hoped, will commend the work to such of the operative classes as are cultivating the study of Botany": also his first book on fungi—*A Plain and Easy Account of British Fungi*—illustrated by twenty coloured plates lithographed by Cooke's youngest brother, E. Cooke. Only the better known of the larger fungi are treated and methods of cooking the edible ones are given. This was the first book that treated fungi in a popular manner, and with the manuals seems to have grown out of Cooke's evening lectures—"Botanical classes established for Operatives."

Cooke now began to aspire to a real knowledge of fungi. He entered into correspondence with the two most eminent British mycologists of that date, M. J. Berkeley and C. E. Broome, and obtained their assistance in many ways. Several of his letters are retained in the Berkeley Correspondence and in the Broome Correspondence, both of which are preserved in the Botanical Department of the British Museum. His energy soon bore fruit, and in the first volume of the *Journal of Botany* (1863) he published a paper on "Rare or new hymenomycetal Fungi," with a coloured plate, and three papers on microfungi in the second volume. In 1863 appeared his *Index Fungorum Britannicorum*, a complete list of the fungi found in the British Isles to that date, arranged so as to be

applicable either as a check-list or for herbarium labels. The "plain and easy" work continued. Several papers on microscopic fungi were written for the *Popular Science Review* during 1863-4, and these were revised and expanded to comprise the well-known *Rust, Smut, Mildew and Mould:* this introduction to the study of microscopic fungi, which was illustrated by J. E. Sowerby, is still used, and is probably the best of Cooke's popular books. Another useful book was his "Easy Guide" to the Hepaticae, reprinted from the first volume of *Science Gossip*, with which it had been issued. In 1867 he published his not very satisfactory *Fern Book for Everybody*. In 1869 we find Cooke writing to Broome that he thought of preparing a handbook to the British fungi at his own risk: and in 1870 his largest undertaking was hinted at when he writes: "I am going in very extensively for these drawings in the hope of publishing an Atlas to my 'Handbook.'" The *Handbook of British Fungi* was published in two volumes in 1871. For several years previously Cooke had been getting the opinions of Berkeley, Broome and other workers on various specimens. Writing to Broome in 1865 he says: "I may be excused for sending you by this post a marked list of my desiderata, so that at any time, should specimens fall in your way, you will not forget a smoke-dried citizen, whose opportunities for finding them himself are limited."

Cooke had also been publishing his *Fungi Britannici Exsiccati* since 1865, and continued to do so until 1879: meanwhile he had arranged the fungi in the British Museum and at the Edinburgh Gardens. The *Handbook* was an immediate success. The prospectus had asked for subscribers at half-a-guinea. "Subscribers will not regret that, instead of 600 pages they will receive more than 900; and instead of 200 figures upwards of 400." Non-subscribers were charged twelve shillings a volume!

Berkeley in the *English Flora* (1836) had rescued the British Fungi from their previous chaos and applied to them the Friesian classification. The number of species he described was 1390. In 1860 was published his *Outlines of British Fungology*. The species in this volume numbered 1450, "but it was so restricted by the publishers as to be of service only to those who possessed the works of Fries and other writers, so far as the more minute forms are concerned, since it contained specific characters of the larger species only, with short descriptions of the families, orders, and genera, accompanied by a list of the remaining species."* The *Handbook* described 2810 species. The book is on traditional lines, and is moreover the last complete British Fungus Flora. In the preface

* Review of *Handbook* by C. E. Broome, Journ. Bot., 1871, p. 312.

the author says: "Pursuing the study of Fungi as a recreation in the intervals of the daily business of life, it was no easy task to prepare and arrange the descriptions of nearly three thousand plants, compare specimens and figures, and measure their spores." No second edition appeared, "for lack of the necessary leisure," but descriptions of the Hymenomycetes were published (1883-91) as an appendix to *Grevillea*. This so-called "second and revised edition" could not compete with Stevenson's *British Fungi* (1886). Writing a few years later Cooke remarks: "If I may judge from my own experience, it is often the case that the individual has little power to control the direction of his studies after he has once started on his course. My own predilections would be in favour of more exclusively physiological investigations, but finding no systematic arrangement of the British Fungi in existence ten years ago, as the basis of operations, I set myself at first to what I conceived the most essential work, and issued the 'Handbook.' Then, I thought, surely it would be permitted me to pursue some course of investigation; but, on the contrary, the publication of the book increased the number and interest of the workers, and gave such an impetus to British Mycology, that at once I became drawn into and involved in a maze of correspondence, not only in the British Islands, but over Europe and America, with regard to the species contained in this book, and the two thousand soon became three thousand; so that in self-preservation and in self-defence I was driven to the study of allied species in other countries, and now I am so committed, by the study of certain groups of which I have consequently acquired a large experience, that I have no alternative but onwards, or to relinquish the study altogether. . . There is still another reason why I am precluded from absolute physiological studies. Having espoused what might be termed strong conservative views on mycological matters, I feel it my duty to science to resist, not only by words, but by work, the innovations of a modern school of Radicalism which threatened to sweep away all old landmarks, and, by wholesale manufacture of new genera and species on illogical, shifting, and unstable bases, to bring science, in so far as Mycology is concerned, into contempt."*

The publication of the *Handbook* had another effect. According to W. G. Smith, Hardwicke, who had published much of Cooke's work, resented the omission to offer him this,† and although Cooke felt that "it would scarcely have

* Journ. Quekett Micros. Club. IV., p. 248 (1877).

† It would seem that this was not the only reason for the split. Hardwicke had found an editor who agreed to do the work at half-price; in any case, the paper deteriorated much in value after Cooke resigned.

been possible to have found a more thorough business man, of a more amiable disposition, prompt, practical, methodical and unassuming," he retired from the editorship of *Science Gossip* and immediately began the well-known cryptogamic periodical *Grevillea*, which he conducted for twenty years (1872-1892). He wrote to Broome when *Grevillea* was about to appear: "Although in London, I work alone, and month after month I never see or speak to any one interested in my own speciality." The paper was at first issued monthly, but after two volumes (by which it had extended "itself at home and abroad so as to attain a circulation exceeding that of any botanical magazine yet emanating from this country") it became a quarterly. Cooke wrote most of it, though he had contributions from the majority of the leading cryptogamists.

In 1875 appeared *Fungi: their Nature, Influence, and Uses* in the International Scientific Series; Cooke was recommended to the publishers by Berkeley who, unable to undertake the work himself from "multiplicity of engagements" and "uncertain health," acted as editor. French and American editions were issued simultaneously: and the book, which clearly shows his all-round and detailed knowledge, was, according to Cooke, almost his only one which proved a commercial success, something like £300 coming to him in royalties.

Early in 1875 he wrote to Berkeley: "It seems an endless task to reconcile the species published by different authorities —hence I think it would be a good piece of work if I could publish coloured figures of all the species possible of *Peziza*, clearing up as much as I can and giving authorities for all the specimens figured." This work he commenced to publish later in the year under the title *Mycographia.** It went on until 1879, during which time only the fleshy Discomycetes had been published, 406 coloured figures and descriptions comprising the first volume. Many further figures had been prepared, but the lack of subscribers caused the cessation of publication—"we have laboured for twelve years on mycological publications, and never yet realized the cost of production (leaving remuneration entirely out of the question)."†

In 1875 Rostafinski published a Monograph on the Mycetozoa, and made it inaccessible to the vast majority of those interested in the subject by writing it in Polish. Cooke procured a Polish grammar and dictionary, made out those parts which he considered relevant to this country, and published it in 1877 as the *Myxomycetes of Great Britain.* The following year appeared *Clavis Hymenomycetum*, written in collaboration

* Cf. Trans. Brit. Mycol. Soc. IV., p. 404 (1914).

† Grev. IX., p. 141 (1881).

with the French mycologist L. Quélet, in which was given a synopsis in Latin of all known European Hymenomycetes.

During this period Cooke was engaged at the India Museum. Here he prepared lists and catalogues and also wrote papers on subjects connected with economic botany and pharmacy, and in 1873 visited Vienna in charge of the Indian Collection for the Austrian Exhibition.

In 1880 the Museum was dissolved and the entire economico-botanical collections "were unreservedly handed over to the Royal Gardens [Kew], the India Office undertaking to pay all the expenses of removal, to expend a sum not exceeding £2,000 in an extension of Museum No. 1 so as to provide the increased space required for the intercalation of a complete set of specimens of Indian vegetable products, to make a grant of £200 a year for the efficient maintenance of the Indian collections, and to place at the disposal of the establishment, three days a week for a period of five years, the services of Dr. Cooke, one of the curators of the Museum under the India Office."* The same Kew Report later states that "Dr. Cooke, besides being at hand to give information in respect to any matter connected with the Indian collections lately under his charge, has undertaken the re-arrangement of the collection of Thallophytes in the Herbarium, as well as the duty of reporting upon questions connected with plant-diseases produced by fungoid organisms which are submitted to Kew. Dr. Cooke has at once attacked the arrears of the section of the Herbarium devoted to fungi, which owing to the press of work in keeping the phanerogams and ferns constantly worked up, has been somewhat neglected." Writing to Broome about this time Cooke says: "I am just now so fully pressed by demands upon my time that I have not a spare hour—nor shall I until my work at Kew is in a more forward state."

In 1881 Cooke had a serious attack of paralysis, which stopped his work for six months. He had engaged to write for the S.P.C.K. a popular *résumé* of Darwin's writings under the title *Freaks and Marvels of Plant Life*. On his way to the printers with the last half-dozen chapters or so he left the manuscript in a 'bus and was unable to recover it—"the notes and memoranda accumulated during some fifteen years had been incorporated, and the originals destroyed."† Cooke managed to supply the copy by the time stated in his contract, but to do this he had to work at tremendous pressure and broke down under the strain. Writing to Berkeley at the end of the year he says: "As for myself I do very well, so long as I

* Kew Report, pp. 56, 62 (1880).

† Freaks and Marvels of Plant Life, p. 274.

restrict myself to examination, etc., of the larger fungi, but as soon as I sit down to the microscope or spend an hour or two in continuous writing, my head compels me to desist, and I fancy it must be some considerable time before I shall be able to undertake any continuous microscopic work." In the same year appeared the first part of the work for which Cooke's name will always be famous, the *Illustrations of British Fungi.* He had long cherished the idea of publishing such a work, and to this end had collected drawings of the rarer species from all the leading British Mycologists. Ten years previously he had written to Broome: "I am going in very extensively for these drawings in the hope of publishing an Atlas to my 'Handbook.'" The work appeared in seventy-six parts and occupied ten years in publication. It contained 1,200 coloured plates and is the largest and most complete work of its kind ever produced. In 1883 Cooke wrote to Broome: "I find that the drawings for my illustrations occupy nearly all my time." He was at one time quite prepared to continue the work and include the whole of the Basidiomycetes, but sufficient subscribers to secure him against pecuniary loss were not forthcoming. It appears from the Broome correspondence that in the early eighties Cooke wished Broome to collaborate with him in getting together all Berkeley's species. "This seems to me to be the best testimony I can offer to Mr. Berkeley at the close of a long and assiduous career" (1880). When Saccardo's *Sylloge* was proposed Broome saw that this work was unnecessary. In the light of later events it is interesting to read Cooke's private comments on Saccardo's project of giving a description of all known fungi. "I am very doubtful whether Saccardo's work will at all interfere with what we have projected—I think not. He would have to devote a whole life to it, and hence I doubt it ever being completed. I have not hitherto permitted it at all to interfere with my intentions. I see no reason why it should in the least interfere with a Sylloge Berkeleyanum" (1882). The work was never published.

During these years, although having so much other work, Cooke, in addition to writing popular books on natural history, turned his attention to freshwater algae, but his three publications *British Fresh Water Algae* (1882-4), *British Desmids* (1887), and *Introduction to Fresh Water Algae* (1890), were far from satisfactory. He himself some years afterwards wrote that "the mycologist of to-day, if he would be master of his subject, must give it his undivided attention and be content with riding but one hobby if he would ride well." Notwithstanding their defects the books were of value in stimulating students to further work on these plants. An excellent account of *British Edible Fungi* appeared in 1891, as well as

his large *Handbook of Australian Fungi.* In 1892 he published a popular volume giving a very good account of entomophagous fungi—*Vegetable Wasps and Plant Worms.* At the end of the year, having reached the age limit (65 years), he retired from Kew. "Besides incorporating the considerable accumulations, he rearranged and brought the whole into excellent order. In consideration of his services at Kew, the Secretary of State for India in Council was pleased to make a small addition to his pension."* He also now gave up the editorship of *Grevillea*, although he continued to contribute to its pages for the two years during which it continued to appear with Mr. G. Massee as editor.

Cooke continued to write articles in various periodicals. One of his last papers, "What is Hygrophorus Clarkii Berk. & Br.?" appeared in the Transactions of this Society for the season 1908. His remaining volumes are: *Handbook of British Hepaticae* (1895), which did not add to his reputation; *Introduction to the Study of Fungi* (1895), a book on similar lines to his volume of 1872, and one which would doubtless have achieved a certain amount of success had it not been published (much against Cooke's wishes) at the absurdly high price of fourteen shillings; and *Fungoid Pests of Cultivated Plants* (1906), an excellent account of plant diseases which had appeared as a series of papers in the *Journal of the Royal Horticultural Society.* His last work on fungi was a *Catalogue and Field-book of British Basidiomycetes* (1910). This was "issued as a protest against a recently published alteration of the nomenclature attached to each species." Though advertised as being "in a convenient pocket size and form" its inconvenient size and shape effectively prevented its use in the field. He left a manuscript dealing with Edible and Poisonous British Fungi, illustrated principally from his *Illustrations.* During this period Cooke, as "Uncle Matt," wrote books on wild flowers for children.

No account of Cooke's career can be considered complete without some reference to his activities in the field. For a number of years he acted as leader at fungus "forays" all over the country. The forays originated with the Woolhope Club. At a meeting in 1867 a Mrs. Key read a paper on *Agaricus Georgii.* Dr. H. G. Bull, who had then just begun the study of mycology, made some comments on the paper, and after describing the edible qualities of certain species remarked that as the fungi of the neighbourhood seemed excellent he thought the Woolhope Club should make them their special study. The meeting was enthusiastic enough to vote

* Kew Bull., p. 144 (1893).

£6, there and then, for the publication of three plates of edible fungi in their Transactions. The following year the Royal Horticultural Society, at the instigation of the Rev. M. J. Berkeley, offered prizes for the best collections of edible fungi. The Woolhope Club gained the first prize, and Mr. W. G. Smith the second. The same autumn an announcement was printed and circulated that an extra field meeting would be held at Hereford "for a Foray amongst the Funguses." Twenty-one persons sat down to dinner at this first foray, which had Messrs. Edwin Lees and W. G. Smith as referees. The scope of the foray, which, at first, was only that of collecting fungi suitable for the dinner, was speedily extended until it included all fungi. The forays continued until 1892. Dr. H. G. Bull, who had been the prime mover in the affair, died in 1886, and this, in conjunction with several "lean" seasons, took the life out of this famous meeting. Continental mycologists used to visit Hereford, every British mycologist of those days was a Woolhopean, and as many as sixty at the Green Dragon dinners was no unusual number. Many other clubs and societies copied these excursions to some degree but could not rival them. Cooke appears to have paid his first visit in 1871. His geniality and wit, as well as his special liking for edible fungi, soon made him one of the leading members. He usually read a paper at the meeting; often this was a humorous contribution, and sometimes he indulged in his old habit of verse making. After Bull's death, Cooke became the leading spirit at the forays. "Certainly the establishment of these Forays had something to do with the preparation and publication of the *Handbook of British Fungi* in 1871, for at once the necessity for such a work became apparent. Later on it was suggested that some compact volume for field work would be an advantage, and in 1878, the *Clavis Hymenomycetum* made its appearance. Finally the excellent series of drawings of Fungi which had been made by Dr. Bull prompted the publication of *Illustrations of Fungi*, which were commenced in 1881 in consequence of the strong recommendation of some of the members of the Woolhope Club."*

During the decline of the Woolhope Club, British Mycologists began to attend the foray of the Yorkshire Naturalists' Union. At the meeting in 1896, at Selby, the idea of a "National Mycological Union," which had been first formally discussed at Huddersfield in the previous September,†

* Trans. Woolhope Club, p. 67 (1892).

† The photograph published in this number was taken at the Huddersfield meeting, and gives a characteristic likeness of Cooke and of the first officers of the Society.

George Massee. Rev. W. Fowler. J. Needham.

Charles Crossland. M. C. Cooke. Carleton Rea.

took shape, and the British Mycological Society was formed, the want of such a Society being due to the cessation of the Woolhope Foray and the discontinuance of *Grevillea*.

In the first year there were 48 members. Mr. George Massee was the first President, Mr. Charles Crossland the first Treasurer, and Mr. Carleton Rea the first Secretary. Cooke by this time was too old to take an active part in the Society, though he contributed papers to the Transactions, which more than replaced *Grevillea* in regard to Fungi and Mycetozoa. Many members have striven hard to place the Society in its proper position, but it is chiefly due to the enthusiasm and energy of Mr. Carleton Rea, who has been secretary since its formation, that it can now show a membership of 138, and a publication that is one of the most important in mycological literature.

In the later years of his life Cooke had serious trouble with his eyes. His health generally was never very good, as he suffered more or less from dyspepsia all his life, and his fondness for patent medicines probably made matters worse. Strange as it may sound, he was not fond of the open air, to which he much preferred a pipe and a book, or a theatre. He was, however, a keen angler. In appearance he was rather slender, with a keen alert look, red hair and beard, and not over careful of his personal appearance. Probably having forgotten his "Struggle for Freedom," he was as conservative in politics as he was in science: in the one he was a prominent member of the Primrose League and in the other he was content to follow the Friesian tradition as expounded by Berkeley, and opposed with all the strength of a vigorous pen the doctrines of lichen symbiosis and heteroecism. "As for my friends, they may rest assured that when I have shuffled off this mortal coil they will be able to say, with confidence, that amidst all my follies and crimes, I was never the advocate of the theories of Table-turning, Tichborne, or Schwendener."* Cooke's increasing blindness, owing to cataract, gradually left him practically helpless. Unable to read, he was still of clear mind, and liked nothing better than that his daughter should read to him popular articles on science when written by authoritative pens. He was particularly interested in those of Sir Ray Lankester, whom he remembered "as a boy in a short Eton jacket" frequenting Hardwicke's shop in company with his father. It is impossible to imagine the sufferings of a man of Cooke's restless energy under such an affliction. He would often write on slips of paper the dates and titles of his more important works, the number of illustrations, etc.—a

* Grevillea VII., p. 126 (1879).

craving for the feeling of having once done something, "to look back with proud satisfaction at all of which we have individually been able to do in aid of the onward progress of this department of Natural Science."

A year or two before his death Cooke underwent an experience that would have given him intense amusement in his younger days, but his course was too nearly run for him to look on the lighter side. This was a premature account of his decease.* The interview in the *Morning Post* on his eighty-seventh birthday gave rise to the report of his death, which received currency in a note in the *Journal of Botany*. The *Kew Bulletin* (p. 369, 1912) gave a sympathetic account of his career, in which it stated that Cooke's "attention was soon attracted to fungi, at first from an edible standpoint, but soon, as Cooke himself often stated, the fungi exercised such a spell over his entire existence, that his interest in these plants ceased only when he peacefully passed away at his residence in Kentish Town on August 19th, a few days after his 87th birthday." Cooke strenuously denied his death, stating it to be "somewhat premature, as I am still alive and lively."

His strength began to fail now at an increased rate. In January, 1914, he left London and went to live with a married daughter at East Southsea. At first he was much better for the change, but after a time heart attacks set in, and he succumbed to old age on November 12th; he was buried at Finchley on November 17th.

In Lindau and Sydow's *Thesaurus* there are some 350 references to Cooke's notes, papers and books. These concern every section of the fungi. His herbarium of 46,000 specimens was purchased in 1887 by Kew, where is also his collection of drawings, computed by the Kew authorities to number 22,000, of which, according to Cooke, 6,000 are original.

Cooke received many honours. Having done much for American mycology, he received the honorary degrees of M.A. (St. Lawrence 1870, Yale 1873) and L.L.D. (New York 1874), and was made honorary member of many American societies. In this country he was elected Associate of the Linnaean Society in 1877, and received the Linnaean Gold Medal in 1903. He was made V.M.H. in 1902, and was an honorary member of most of the British Natural History Societies. He was also honorary member of the Société Mycologique de France.

Cooke had a greater influence on the study of fungi than any other Englishman with the possible exception of Berkeley.

* This does not appear to have been his only experience of such a fate, as in a letter to him, dated 1864 (now in the Department of Botany, British Museum), occurs the following sentence: "I am glad to hear you are alive, I having heard from several parties that you were *dead*."

Much of his work, it must be admitted, was somewhat slipshod and much of it "scissors and paste." But his *Handbook*, *Illustrations*, *Mycographia*, and *Grevillea*, together with his efforts to popularize the study of fungi, enable us to realize his place in Mycology.

I am indebted to Miss Leila A. Cooke for her kind assistance in many ways.

WILLLIAM LEIGH WILLIAMSON EYRE.

(1841-1914.)

By J. Ramsbottom, M.A.

The British Mycological Society has suffered a great loss through the death, on October 25th, 1914, of the Rev. W. L. W. Eyre, one of its most loyal members. Mr. Eyre was born at Padbury, Bucks, on March 17th, 1841. Educated for the merchant service, he went to sea at an early age, but gave up sea-faring to enter Lichfield College as a theological student. He was ordained deacon in 1865 and priest in 1866, in Lichfield Diocese. His first curacy was at Sheriff Hales, Staffordshire, 1865-8. Afterwards he was curate of West Dean, Wilts., 1868-70; of Huntley, Gloucester, 1870-72; and Northchurch, Hertfordshire, 1872-5. In 1875 he was appointed rector of Swarraton and vicar of Northington, Hants, by the then Lord Ashburton. Mr. Eyre early took up the study of fungi, and was a member of the Woolhope Club during the later years of its mycological activities. When the British Mycological Society was formed in 1896, he at once became one of its most enthusiastic members, and up to the time of his death took the greatest possible interest in everything that affected the Society. For a number of years he most generously provided the Transactions with a coloured plate, realising the great necessity of such in the study of Basidiomycetes. For the season 1903 he was elected President, and gave as his address "Mycology as an instrument of recreation." The only other paper he wrote for the Transactions is "Notes on Hants Fungi" (1899), a most suggestive paper giving his experiences as to the relation of certain fungi to edaphic conditions. He was responsible for the list of Hampshire fungi in the Victoria County History, and in 1907 published "A list of the fungi of the Grange Park and neighbourhood, Hampshire." The repu-

tation he held amongst Mycologists was that of doing most careful field work, in which he was always encountering rare or new agarics. His attention was not, however, restricted to these, but any microfungi which seemed sufficiently distinct he forwarded to the one of his many mycological friends whom he thought it would most interest. He gave great assistance to M. C. Cooke in the preparation of his *Illustrations* by providing him with many rare species. After Dr. Cooke's retirement the new finds were sent to Mr. G. Massee, but since the foundation of the British Mycological Society they have been named or described by Mr. Carleton Rea and by Miss Lorrain Smith. A glance through the past volumes of the Transactions will reveal the large number of new records which are due to Mr. Eyre's activities. Many of these, and all the new species, have been illustrated in the Transactions by Mrs. Rea. He commemorated his happy hunting grounds in naming a fungus he described *Schulzeria Grangei*, but apart from this he appears to have been well-content to send the plants which he had exhaustively examined to a recognised authority for determination or description. He was an ardent Naturalist, and was a member of the Hampshire Field Club from its formation, publishing several papers, principally on fungi, in the *Papers and Proceedings* of the Club. For many years he made a close study of the genus *Rubus*, and his collection, together with that of the Mycetozoa, is in the Educational Museum at Haslemere. He was also interested in land and freshwater shells and made a very complete collection of those occurring in North Hampshire. Mosses and archæology also claimed part of his attention—and he wrote a history of the parish of which he was vicar for so many years. He was a fellow of the Royal Meteorological Society and for a long period kept tabulated records of the district round Swarraton. The illness which preceded his death was long and painful. During the last few years Mr. Eyre rarely attended the meetings of the Society. The photograph of the first Haslemere meeting (1905), published in this number, shows Mr. Eyre as he was best known to the members, and in addition the group includes many of the past presidents and older members to whom the Society has been so much indebted in the past.

Mr. Eyre's geniality (which seemed to have a trace of the sea), his great enthusiasm, his wide outlook on Nature, and his generosity will be much missed amongst his many friends.

The species *Chlorospora Eyrei* Mass. and *Sebacina (Bourdotia) Eyrei* Wakefield* have been named in his honour.

I am much indebted to Miss Eyre for her kindness in supplying me with information.

* *Cf.* p. 126.

Published 10th May, 1915.

A. D. Cotton. A. Adams. J. F. Rayner. H. G. Peacock. J. Hutchinson. D. Taylor. W. Watson. Renfrie. D. Mackenzie.
E. W. Swanton. A. Lister.

J. Eyre. A. Fry. A. Lorrain Smith. Gulielma Lister. C. B. Plowright. Mrs. E. A. Rea. C. Rea. R. H. Biffen (President). G. C. Hughes. C. P. Bird. Mrs. Bird.
Mrs. A. Montague. E. Plowright. W. L. W. Eyre. Mrs. Biffen. Mrs. Swanton. M. K. Spittal.

The British Mycological Society. Haslemere Foray, 25th to 30th September, 1905.

BASLOW SPRING FORAY.

21st to 25th May, 1915.

The seventh annual spring foray of the British Mycological Society was held at Baslow, Derbyshire, from Friday the 21st of May, to Tuesday the 25th of May, 1915. The members assembled at the headquarters, The Grand Hotel and Hydro, Baslow, on the Friday, and a room in the basement was reserved for the exclusive use of the Society. On Saturday, the 22nd of May, at 10 o'clock, the members set out from the headquarters and proceeded through the village of Baslow and Chatsworth Park to the rendezvous at Calton Lees saw mill. Here they were met by Mr. J. P. Robertson (head forester to the Duke of Devonshire) and a considerable time was spent in its investigation. Two large masses of brownish black plasmodia, on a fairly big sawdust heap, first attracted attention, and subsequently some wind and sun dried sporangia of the somewhat rare myxomycete *Lindbladia effusa* Rost. were obtained on a similar substratum. Lindup plantation was next visited. This wood was carpeted with dense growths of *Claytonia sibirica*, and in the lower portions a fair amount of old logs and fallen branches were found lying about. These were industriously turned over, but yielded nothing of interest, though the ravages caused by the destructive parasite *Armillaria mellea* were everywhere in evidence. A traverse was then taken across the meadows and the river Derwent to the old Oak Park at Chatsworth. This is a remnant of the famous forest of Sherwood, and still contains many fine oaks which must have flourished at its prime. The woods to the east of Chatsworth House were next explored and the return walk taken to Baslow.

On the following day the Yeld Wood, at the rear of the headquarters, and the adjacent moors were worked, but owing to the long drought that had prevailed before the foray, only specimens of *Pseudombrophila tenuispora* (Cke. & Massee) Boud. and *Sclerotinia Curreyana* (Berk.) Karst. are worthy of note.

On Monday, the 24th of May, the members started from the headquarters at 10-30 to meet Mr. J. P. Robertson at Toast Bank, Hassop. This plantation, which had become the prey of numerous fungus parasites before Mr. Robertson took over

its administration, is now treated as a game reserve. Here the conditions were moister, and Mr. W. B. Allen found some nice examples of *Corticium subcoronatum* v. H. & L. and *Trametes rubescens* (A. & S.) Fr. Dr. J. W. Ellis and Mr. A. D. Cotton also obtained a nice gathering of the Pyrenomycete *Diaporthe longirostris* (Tul.) Sacc.* on *Acer Pseudoplatanus*, and this determination was most kindly confirmed by the eminent Italian mycologist Professor P. A. Saccardo. This is an addition to the British Fungus Flora. The former also gathered an undescribed *Septomyxa*, *S. fagicola* J. W. Ellis.† The walk was then continued through Three Nooks plantation back to Baslow.

In the evening at the business meeting of the Club, the President (Mrs. E. A. Rea) took the chair. Hearty votes of thanks were unanimously passed to Mr. J. P. Cockerell for kind permission to visit the Duke of Devonshire's woods on the Chatsworth estate, and to Mr. J. P. Robertson and his son for their leadership in the field, and the selection of the best woods to visit. On the proposition of Mr. H. W. Harrison, seconded by Mr. W. H. Holt, it was decided to hold the Whitsuntide week-end spring foray for 1916 at Grange-over-Sands, Lancashire.

On Tuesday, the 25th of May, the members drove to Hassop and took the 11-14 a.m. train to Monsal Dale station. From thence they proceeded under the conductorship of Mr. H. W. Harrison up the valley of the river Wye and via Cressbrook and Ravensdale to Wardlow Cop. Some of the members proceeded along the roadway up the dale, and Dr. J. W. Ellis secured some specimens of *Hypoderma Hederae* (Mart.) de Not. Others, more adventurous, crossed the brook and clambered through the wooded gorge. On reuniting, Mr. A. D. Cotton reported that he had found *Hyalopsora Polypodii* (Pers.) Magn. growing on *Cystopteris fragilis*, and he and Mr. Harrison handed over to Mr. Carleton Rea numerous specimens of a Discomycete which was subsequently ascertained to be undescribed and named *Dermatea nidulariformis* Rea.§ The return journey was made by the 6-3 p.m. train to Bakewell and Baslow.

About one hundred and fifty-five species of fungi were collected during the foray, and Mr. W. B. Allen sent in the appended list of twenty-two mycetozoa.

* For description of this species see p. 228.

† For description of this species see p. 231.

§ For description of this species see p. 256.

COMPLETE LIST OF FUNGI GATHERED DURING THE FORAY.

C. = Calton Lees sawmill; *Ch.* = the Old Oak Park and Stand Wood, Chatsworth; *L.* = Lindup Wood; *M.* = Monsal Dale; *N.* = Three Nooks Plantation; *T.* = Toast Bank Plantation; *Y.* = The Yeld Wood and moors north-east of Baslow.

Tricholoma gambosum Fr., *Y.*

Collybia fusipes (Bull.) Berk., *C.*, velutipes (Curt.) Fr., *M.*, dryophila (Bull.) Fr. var. funicularis Karst., *N.*

Mycena galericulata (Scop.) Fr., *N.*, tenella Fr., *Y.*, tenerrima Berk., *Y.*

Omphalia umbellifera (Linn.) Fr. *Ch.*

Panus stypticus (Bull.) Fr., *L.*, *T.*, *Y.*

Lenzites betulina (Linn.) Fr., *Y.*

Pluteus cervinus (Schaeff.) Fr., *T.*, *Y.*

Nolanea pascua (Pers.) Fr., *Y.*

Pholiota praecox (Pers.) Fr., *C.*, aegerita Fr., *Y.*, mutabilis (Schaeff.) Fr., *Y.*, marginata (Batsch) Fr., *T.*

Galera tenera (Schaeff.) Fr., *L.*, *M.*, hypnorum (Schrank) Fr., *T.*

Tubaria furfuracea (Pers.) W. G. Sm., *L.*, *T.*

Psaliota campestris (Linn.) Fr., *Y.*, arvensis (Schaeff.) Fr., *Y.*

Stropharia aeruginosa (Curt.) Fr., *Y.*, semiglobata (Batsch) Fr., *M.*

Hypholoma epixanthum (Paul.) Fr., *L.*, *Y.*, fasciculare (Huds.) Fr., *T.*, *Y.*

Psilocybe foenisecii (Pers.) Fr., *L.*

Psathyra corrugis (Pers.) Fr., *L.*

Coprinus micaceus (Bull.) Fr., *C.*, *T.*, radians (Desm.) Fr., *C.*, *T.*, plicatilis (Curt.) Fr., *Ch.*

Psathyrella atomata Fr., *M.*, disseminata (Pers.) Fr., *Ch.*

Polyporus brumalis (Pers.) Fr., *T.*, squamosus (Huds.) Fr., *M.*, *Y.*, nummularius (Fr.) Quél., *C.*, adustus (Willd.) Fr., *M.*, *T.*, *Y.*, betulinus (Bull.), *T.*, *Y.*

Fomes igniarius (Linn.) Fr., *T.*, ferruginosus (Fr.) Massee, *T.*, annosus Fr., *C.*, *L.*, *T.*, *Y.*

Polystictus radiatus (Sow.) Fr., *T.*, versicolor (Linn.) Fr., *C.*, *T.*, *Y.*, abietinus (Dicks.) Fr., *T.*

Poria sanguinolenta (A. & S.) Fr., *Ch.*

Trametes rubescens (A. & S.) Fr., *T.*

Daedalea quercina (Linn.) Fr., *L.*
Grandinia granulosa Fr., *T.*
Hydnum farinaceum (Pers.) Fr., *T.*
Irpex obliquus (Schrad.) Fr., *L.*, *T.*, *Y.*
Stereum hirsutum (Willd.) Fr., *C.*, *T.*, *Y.*, spadiceum (Pers.) Fr., *Ch.*, *T.*, sanginolentum (A. & S.) Fr., *C.*, rugosum (Pers.) Fr., *Ch.*, *M.*
Hymenochaete corrugata (Fr.) Lév., *Y.*
Corticium Sambuci (Pers.) Fr., *Y.*, subcoronatum v. H. & L., *T.*, praetermissum (Karst.) Bres., *T.*, porosum B. & Br., *Y.*
Peniophora cinerea (Pers.) Cke., *Ch.*, *T.*, quercina (Pers.) Cke., *L.*, *T.*, *Y.*, subalutacea (Karst.) v. H. & L., *L.*, *T.*
Solenia anomala (Pers.) Fr., *C.*, ochracea (Hoffm.) Fr., *T.*
Dacryomyces deliquescens (Bull.) Duby, *C.*, stillatus (Nees) Fr., *Y.*, chrysocomus (Bull.) Tul., *Y.*
Phallus impudicus (Linn.) Pers., *Y.*
Mutinus caninus (Huds.) Fr., *L.*
Sphaerobolus stellatus (Tode) Pers., *C.*
Uromyces Ficariae (Schum.) Lév., *Y.*, Scillarum (Grev.) Wint., *L.*, *M.*, *Y.*, Poae Rabenh., *M.*, *Y.*
Puccinia Violae (Schum.) DC., *M.*, *Y.*, pulverulenta Grev., *Haddon Hall, on Epilobium hirsutum*, Adoxae Hedw. fil., *L.*, *T.*, obtegens (Link) Tul., *T.*, Winteriana Magn., *M.*, *on Allium ursinum.*
Phragmidium mucronatum Schlecht., *Ch.*, *L.*
Hyalopsora Polypodii (Pers.) Magn., *M.*, *on Cystopteris fragilis.*
Melampsora Rostrupii Wagn., *M.*, *on Mercurialis perennis.*
Ustilago violacea (Pers.) Wint., *L.*, *T.*, *M.*
Sphaerotheca pannosa (Wallr.) Lév., *Ch.*, *Y.*
Podosphaera Oxyacanthae (DC.) de Bary, *L.*
Erysiphe Cichoracearum DC., *Haddon Hall*, *on Parietaria officinalis.*
Nectria cinnabarina (Tode) Fr., *Y.*, coccinea Fr., *T.*, episphaeria (Tode) Fr., *T.*, *Y.*
Hypomyces rosellus (A. & S.) Tul., *Y.*, *on Polyporus betulinus.*
Leptospora ovina (Pers.) Fuck., *T.*
Bertia moriformis (Tode) de Not., *Ch.*
Melanomma Pulvis-pyrius (Pers.) Fckl., *C.*, *Ch.*, *L.*, *T.*
Zignoella pulviscula Sacc., *T.*
Ceratostomella cirrhosa (Pers.) Sacc., *T.*
Calospora alnicola Cke. & Massee., *T.*, *on Alnus.*
Leptosphaeria acuta (Moug. & Nestl.) Karst., *C.*, *M.*, *T.*, *Y.*
Diaporthe longirostris (Tul.) Sacc., *T.*, *on Acer* (new to Britain).
Eutypa scabrosa Fckl., *Ch.*, lata Tul., *T.*
Cryptospora suffusa (Fr.) Tul., *Ch.*, *on Alnus.*
Melanconis stilbostoma (Fr.) Tul., *L.*, thelebola (Fr.) Sacc., *T.*, *on Alnus.*

Diatrypella quercina (Pers.) Nke., *L.*, *T.*, *Y.*
Diatrype stigma Fr., *T.*
Hypoxylon semiimmersum Nke., *Ch.*, fuscum (Pers.) Fr., *T.*
Xylaria hypoxylon (Linn.) Grev., *T.*
Phyllachora Graminis (Pers.) Fckl., *L.*, Junci (Fr.) Fckl., *Y.*
Rhopographus Pteridis (Sow.) Wint., *Y.*
Pseudombrophila tenuispora (Cke. & Massee) Boud., *L.*, *T.*, *Y.*
Lasiobolus equinus (Müll.) Karst., *Ch.*
Cudoniella acicularis (Bull.) Schroet., *T.*, *Y.*
Ombrophila clavus (A. & S.) Cke., *T.*
Pachydisca brunnea (Phill.) Boud., *Y.*
Calloria fusarioides (Berk.) Fr., *M.*
Orbilia xanthostigma Fr., *T.*, *Y.*
Sclerotinia Curreyana (Berk.) Karst., *Y.*
Helotium virgultorum (Wahl.) Karst., *Y.*
Dasyscypha virginea (Batsch) Fckl., *T.*, *Y.*, nivea (Hedw. fil.) Sacc., *C.*, *T.*
Trichoscypha calycina (Schum.) Boud., *C.*, *T.*, *Y.*
Hyaloscypha hyalina (Pers.) Boud., *T.*
Mollisia cinerea (Batsch) Karst., *C.*, *L.*, *T.*, *Y.*, melaleuca (Fr.) Sacc., *L.*, *M.*, *T.*
Tapezia fusca (Pers.) Fckl., *T.*
Heterosphaeria patella (Tode) Grev., *L.*, *Y.*
Dermatea nidulariformis Rea* (new to Science).
Propolis faginea (Schrad.) Karst., *Ch.*
Stegia Ilicis Fr., *Y.*
Rhytisma acerinum (Pers.) Fr., *Y.*
Hypoderma conigenum (Pers.) Cke., *T.*, Hederae (Mart.) de Not. *M.*
Plasmopara pygmaea (Unger) Schröt., *Y.*
Peronospora parasitica (Pers.) Tul., *Y.*, Schleideni Unger, *M.*, *on Allium.*
Phyllosticta Mahoniana (Sacc.) Allescher, *Y.*, *on Mahonia Aquifolium.*
Phoma Ryckholtii Sacc., *M.*, *on Symphoricarpus racemosa*, complanata (Tode) Desm., M., acuta Fckl., *Ch.*, *T.*, *Y.*, Urticae Schultz. & Sacc., *Ch.*, *M.*, *T.*, *Y.*
Leptostroma Spiraeae Fr., *Y.*
Macrophoma collabens (Cke.) Berl. & Vogl., *Y.*, *on Prunus lusitanica.*
Cytospora ambiens Sacc., *Y.*, carphosperma Fr., *Y.*
Ascochyta teretiuscula Sacc. & Roum., *Y.*, *on Luzula pilosa.*
Septoria Hederae Desm., *M.*
Leptostromella juncina (Fr.) Sacc., *Y.*
Discella carbonacea (Fr.) B. & Br., *T.*

* For description of this species see p. 256.

Melanconium sphaeroideum Link, *Y.*, *on Alnus glutinosa*, bicolor Nees, *Y.*
Septomyxa fagicola J. W. Ellis† (new to Science).
Cryptosporium Neesii Cda., *Ch.*
Trichoderma lignorum (Tode) Harz, *C.*, *T.*, *Y.*
Rhinotrichum repens Preuss., *T.*
Trichothecium roseum (Link) Grev., *C.*
Tilachlidium tomentosum (Schrad.) Lindau, *T.*

MYCETOZOA COLLECTED AT THE SPRING FORAY AT BASLOW, MAY 22-25, 1915.

By W. B. Allen.

The Spring Foray at Baslow was characterised by an abnormal drought, which boded ill for any great success in the collection of Mycetozoa.

Derbyshire had not enjoyed the heavy storms which prevailed in the Southern Midlands a week or so before Whitsuntide, consequently the bare moorland meadows and shallow exposed woods were scorched up, and proved to be unproductive. Under these conditions the compiling of a list of twenty-two species was as good as might have been expected, and represents the result of laborious gleaning to obtain records of even very common kinds.

The first day was spent in an expedition to a portion of the Chatsworth Estate: part of the old Deer Park, Lindup Wood, and Calton Lees Saw Mill.

At this latter place Mr. Carleton Rea collected the best find that was made, viz., *Lindbladia effusa* Rost., and Mr. Harrison secured a few minute and scattered sporangia of *Cribraria aurantiaca* Schrad. on very rotten wood, which fell almost to powder in the collecting box on the journey home, so that some little pains were needed to extract the minute specimens.

The second day was devoted to the exploration of Yeld Wood, immediately adjoining the Hydro. This proved so unproductive that the members soon made their way on to the open moorland beyond, but here again everything was dried up, and as a last resource many members found their way to a neighbouring stream, in the hope of meeting with better conditions. The stream, however, proved to be too rocky and with little or no timber lying about its banks. The only notable

† For description of this species see p. 231.

feature was a quantity of *Reticularia Lycoperdon* Bull. growing on the alder trunks, in some instances as much as 10ft. from the ground.

On the third day the members had a walk of some three miles or so, along dusty roads lined with hedges white as snow, from motor-driven dust, until they met Mr. Robertson, who was waiting to conduct them into Toast Bank and Three Nooks Woods.

Mr. Robertson apologised for the state of these woods from a forestry point of view, and this cheered one up considerably regarding the prospect of finding Mycetozoa.

The first covert was certainly a wilderness of fallen trees lying on the ground, in some places on damp boggy slopes adjoining a rippling brook, and gave every appearance of being a wonderfully good hunting ground.

The timber, however, proved barren, and the most common species were not in abundance; some gatherings that were taken sufficed only to make a bare record, as they were mouldy and dried almost beyond recognition.

The fourth day took the members to Monsal Dale, but no Mycetozoa were collected on this day, as the ground was too dry.

The following is a list of species found during the Foray:—

Ceratiomyxa fruticulosa (Muell.) Macbr.

Toast Bank Wood. Part of the gathering pale pink in colour.

Badhamia utricularis Berk.

Plasmodium and ripe sporangia found at Calton Lees Saw Mill.

Physarum nutans Pers. sub-sp. *leucophaeum* Lister.

Toast Bank Wood. Specimen very mouldy.

Craterium minutum Fr.

Calton Lees Saw Mill.

Leocarpus fragilis Rost.

On moor land near Yeld Wood. The spores 12μ, spinulose, spot of dehiscence pale.

Didymium difforme Duby.

This sporting development was found near Yeld Wood. The capillitium showed many expansions, containing yellowish-olive irregular lime granules. The spores were typical.

D. squamulosum Fr.

On leaves near Yeld Wood.

Stemonitis fusca Roth.

Toast Bank Wood.

A very old and caked gathering, but spores show the species.

Comatricha nigra Schroet.

Yeld Wood, Calton Lees, and Toast Bank Wood.

Enerthenema papillatum Rost.

Toast Bank Wood.

This gathering was found on the splintered trunk of a tree, whose top had been broken off, probably by another falling tree. The specimens were very mouldy and for the most part immature and merely dried horny beads of plasmodium. Only one ripe sporangium was found, and this was badly attacked by mould.

Lindbladia effusa Rost.

Calton Lees Saw Mill.

This rare and interesting species is, as far as we know, a first record for Derbyshire. It was brought in by Mr. Carleton Rea, who found it growing on sawdust. The specimen was a roughly circular patch, some three inches in diameter, and consisted of a mass of sporangia. many quite immature and dried, which were heaped and piled together in an irregular form, like miniature mountains of shining black. The whole was seated on a strong hypothallus about one-eighth of an inch thick, which on section resembled a layer of liquorice and was of a tough and leathery consistency.

The spore-mass, where mature, was a snuff-coloured powder, and portions of the sporangium wall, taken with the spores, showed a rich brown colour, and were studded with dark plasmodic granules. The spores, of a pale brown colour, were minutely warted, and measured 5-6μ. The plasmodium of this species was black, like "bletch" from a greasy axle.

Cribraria aurantiaca Schrad.

Calton Lees Saw Mill.

Reticularia Lycoperdon Bull.

This early summer species was abundant in all the places visited.

Lycogala epidendrum Fr.

Abundant in all places.

Trichia affinis de Bary.

Yeld Wood and Toast Bank Wood.

One gathering showed an intermediate form between *T. affinis* and *T. persimilis*, having the spores of the former and the small dull sporangia of the latter.

T. varia Pers.

Toast Bank Wood.

T. decipiens (Pers.) Macbr.

Toast Bank Wood.

T. Botrytis Pers.

Yeld Wood and Toast Bank Wood.

The gathering from Yeld Wood was the new variety which was subsequently described in the Journal of Botany for July 1915 in a paper Mycetozoa of Australia and New Zealand as var. *cerifera* List., from the walls being spotted with deposits of yellow wax, partly on the surface and partly in blister-like pouches within the walls.

Arcyria ferruginea Sauter.

Yeld Wood.

A. incarnata Pers.

Yeld Wood.

A. denudata (Linn.) Sheldon.

Toast Bank Wood.

Perichaena corticalis Rost.

Calton Lees and Toast Bank Wood.

THE SWANSEA FORAY.

27th September to 2nd October, 1915.

The nineteenth annual week's fungus foray of the British Mycological Society was held at Swansea, on the invitation of the Swansea Field Naturalists' Society. The Council of the Royal Institution most kindly placed a commodious room at their disposal, and this constituted the headquarters for the meeting. At the request of several members, the President (Mrs. Emma Amy Rea), with the indefatigable assistance of several enthusiastic members of the Swansea Society, exhibited a portion of her original water colour paintings of British Fungi. These were placed in frames kindly lent by the Swansea Arts and Crafts Committee, and were arranged in systematic sequence on the walls of the room.

On Monday, the 27th of September, 1915, the members assembled at the Royal Institution, Swansea, and during the course of the evening some fungi were placed out on exhibition. Dr. H. G. Peacock brought a fine specimen of *Xylaria polymorpha* (Pers.) Grev. from the neighbourhood of Torquay. Mr. C. P. Bird sent a characteristic example of *Geaster rufescens* Pers. var. *minor* Pers. from the vicinity of Hereford. From Cambridge Mr. F. T. Brooks forwarded *Pleurotus corticatus* Fr., and from Looe Dr. A. Adams consigned *Clavaria stricta* (Pers.) Fr.

On Tuesday, the 28th of September, a start was made from the headquarters at ten o'clock, and the Mumbles tram railway taken to Blackpill. A short walk soon brought the members to the Lower Lodge entrance to Sketty Park. There the pastures and woods were carefully worked, and near to an old chapel on some old worked beams lying amongst the grass a Merulius new to Britain was found by the Hon. Sec., namely, *Merulius papyraceus* Fr.* A little further on some specimens of *Crepidotus nidulans* (Pers.) Quél. were growing on the dead trunk of a standing Scotch Pine. This was first recorded as British at a foray at Byfleet in 1913. Dr. J. W. Ellis also obtained some examples of *Schizophyllum commune* Fr. from a living branch of a Beech tree. Numerous specimens of *Femsjonia luteo-alba* Fr. were collected, and this species, some-

* For description of this species see p. 252.

what uncommon elsewhere, was recorded for each day of the foray, and Mr. A. D. Cotton on one occasion found it growing on a living oak branch. The walk was then continued through New Mills Wood, Rhydydefaid Beech Woods, and the Rhydydefaid Woods to Killay station, where the 3-40 p.m. train was taken to Swansea. Miss Gulielma Lister subsequently handed in a fine specimen of *Inocybe duriuscula* Rea.

In the evening, at nine o'clock, the President (Mrs. E. A. Rea) took the chair, and the following officers were unanimously elected for the ensuing year:—E. W. Swanton, President; Miss Gulielma Lister, F.L.S., Vice-President; and Mr. Carleton Rea, B.C.L., M.A., &c., Hon. Secretary and Treasurer. After much discussion, it was resolved that the autumn foray for 1916 should be held in the New Forest during the last week in September, with Lyndhurst as a centre. The Hon. Secretary reported that at the spring foray held at Baslow it was resolved that the ensuing one should take place at Grange-on-Sands, at the usual Whitsuntide week-end. Since then it had been ascertained that this meant the third week in June, and it was accordingly resolved to alter the date to Eastertide, namely, 20th to 25th April, 1916. Miss A. Lorrain Smith, F.L.S., was appointed delegate to represent the British Mycological Society at the Conference of Delegates of Corresponding Societies of the British Association in 1916, and the thanks of the Society were tendered to Mr. J. Ramsbottom, M.A., for the able way in which he had introduced the discussion on "Colour Standards" on their behalf at the recent Manchester meeting. The Hon. Treasurer reported that all outstanding liabilities, including the costs of the programme for the present foray, had been paid, and that the sum of £5. 9s. 10d. now stood to their credit at the bank. The list of members now numbered one hundred and thirty-nine, and included five new members elected since the last autumn foray, namely, Mr. G. Bryce, B.Sc., Assistant Botanist and Mycologist, Royal Gardens, Peradeniya, Ceylon; Miss J. C. Eyre, Maitlands Cottage, Ippelpen, Newton Abbott, Devon; The Library University Farm St. Paul, Minn., United States of America; Mr. R. M. Richards, A.R.C.Sc., The Laboratory, Caledonia Estate, Province Wellesley, Straits Settlement; and Mr. W. Small, Government Botanist, Department of Agriculture, Kampala, Uganda, via Mombasa, B.E.A. The Rev. J. Harvey Bloom, M.A., Whitchurch Rectory, Stratford-on-Avon, was then unanimously elected a member. A letter was then read from their member, Dr. J. W. Scott Macfie, offering some cultures of fungi imperfecti obtained by him from human skin in West Africa and inquiring if there was any member who would undertake their identification. None of the members present

at the meeting felt they were in a position to continue these cultures, but they all agreed that if they subsequently heard of anyone who would do so, they would communicate with Dr. Macfie. Mr. Carleton Rea, B.C.L., M.A., then read a short paper "On Dry-rot (*Merulius lacrymans* (Wulf.) Fr.) and its prevention." This had been prepared at short notice at the request of Mr. H. R. Wakefield, on behalf of the Swansea Society, as it was a subject of great importance at the present time in Swansea where dry-rot was rampant.

On Wednesday, the 29th of September, the forenoon was devoted to the placing out on exhibition the fungi and mycetozoa collected on the previous day. At 11-30 a.m. a motor was in attendance at the headquarters and conveyed the members to Penypool and Moorlakes. A traverse was first taken across Smear Moor, where *Hygrophorus subradiatus* (Schum.) Fr. was found. A young plantation of Oak, Birch and Scotch Pine was then entered, and yielded little of interest with the exception of *Trametes rubescens* (A. & S.) Fr., which abounds on Alders in the Gower peninsula. The walk was then continued past Saint Iltyd Church and through the pastures bordering the Ilston brook to Gower Inn, the most noteworthy fungi collected on the way being *Lepiota alba* Bres., *Mycena virens* (Bull.) Quél., *Hygrophorus obrusseus* Fr., *Clavaria Kunzei* Fr., and a magnificent growth of *Clavaria stricta* (Pers.) Fr. brought in by Mr. A. D. Cotton. The sandy soil of Pennard Pill was searched in vain for specimens of the rare *Tulostoma mammosa* (Mich.) Fr., which has on one occasion been recorded from this locality. A few members ascended the steep ascent to Pennard Castle and inspected the dried-up remains of the phanerogamous rarity *Draba aizoides*. The return was then taken over the golf links to the Gower Inn, from whence the motor conveyed them back to Swansea. In the evening, at 7-30, the Club dinner was held at the Hotel Metropole, and there was a good attendance of members of the Swansea Field Naturalists' Club. Their President (Mr. J. Percy Player) warmly welcomed the Society's visit to Swansea and trusted that the results of the week's investigations would add to the mycological records for the Gower peninsula. At the headquarters, at nine o'clock, Mrs. E. A. Rea delivered her presidential address entitled "Notes on Fungus Illustrations" (see p. 211).

On Thursday, the 30th of September, the members assembled at the Great Western Railway Station, and took the 11-10 a.m. train to Skewen. On arrival at Skewen Mr. W. C. Llewellyn conducted them up the hill and along the course of the railway to Darran Wood. These woods were very dry and few fungi were obtained, and this applied equally to the

adjoining Stanley Wood and Mountain Pine Wood. Our new member, the Rev. J. Harvey Bloom, handed in the most interesting find of the day, *Tricholoma variegatum* (Scop.) Fr. from the Mountain Pine Wood, and this locality subsequently yielded on dung some specimens of *Cheilymenia dalmeniensis* (Cke.) Boud. A few specimens of *Cortinarius (Dermocybe) azureus* Fr. and *Paxillus panuoides* Fr. were also obtained In these woods Miss E. M. Wakefield subsequently reported the discovery of *Tulasnella incarnata* Juel.* which is an addition to the British Fungus Flora. On emerging from these woodlands a weary tramp was taken over high moorland and unproductive ground to the house of the President of the Swansea Field Naturalists' Society. Here the members were most cordially received by Mrs. J. P. Player and the President. After tea, the members of the two Societies were photographed on the steps of the terrace overlooking the Swansea valley. Mrs. E. A. Rea then tendered their very hearty thanks to their host and hostess for their kind hospitality, and the return journey to Swansea was made by tramcar. Subsequently, at a somewhat late hour, in the drawing-room of the Hotel Metropole, Mr. J. Ramsbottom, M.A., F.L.S., read two papers, "Notes on the History of the Classification of the Phycomycetes" (see p. 324) and "Colour Standards" (see p. 263).

On Friday, the 1st of October, at mid-day, a motor-car conveyed the members from the headquarters to Cillibion Plantation. This wood is of considerable extent, and consists of oaks, alders, and ashes, intermixed with some conifers. Fungi were more abundant than on the previous days and included the following:—*Cortinarius (Inoloma) callisteus* Fr., *Sistotrema confluens* (Pers.) Fr., *Lactarius obnubilus* (Lasch) Boud., *Peniophora aurantiaca* Bres., and *Peniophora longispora* (Pat.) v. H. & L. Miss E. M. Wakefield was also successful in finding *Tomentella subfusca* (Karst.) v. H. & L.† for the first time in Britain. About 3-30 p.m., a move was made to Green Cwm, where specimens of *Hygrophorus clivalis* Fr., *Pholiota aegerita* Fr., and *Lepiota sistrata* Fr. were obtained. The car was re-entered at the Gower Inn and Swansea reached shortly after 6 p.m.

In the evening the President at the headquarters took the chair at nine o'clock. Mr. A. D. Cotton, F.L.S., showed some coloured lantern slides of British Clavariae, and Mr. H. R. Wakefield several black and white slides of local fungi. A discussion then followed on the various points raised by Mr. J. Ramsbottom in his paper on "Colour Standards," read the

* For description of this species see p. 254.

† For description of this species see p. 253.

previous evening. Hearty votes of thanks were passed to Lady Lyons (Kilvrough), Miss Vivian (Clyne Castle), Miss Talbot (Penrice), Sir R. Morris, Bart. (Sketty), and Mr. H. N. Miers (Ynyspenllwch), for the kind permission they had given the members to visit their estates; and to the Council of the Royal Institution for placing the excellent room at their disposal. Special thanks were accorded to Mr. H. R. Wakefield for all the trouble that he had taken in arranging the details of the programme for the foray, for his able leadership in the field, and for the arduous work that he and his assistants of the Swansea Field Naturalists' Society, Messieurs Bryn George, B.Sc., H. de G. Langlois, C. Perkins, J. A. Webb, B.A., and W. G. Williams, had rendered in hanging the paintings of the President, and their subsequent removal. Three hundred and ninety-seven species of fungi were collected during the foray, and over two hundred of these were additions to the List of Fungi from the Swansea District that Mr. H. R. Wakefield had prepared and kindly distributed to our members before the foray. This must be considered a fairly satisfactory result of the week's work, because in this phenomenal year, owing to the torrential rain that prevailed during the month of July the frondose woods became saturated with moisture and the succeeding heat of August provided during the last three weeks thereof and the first week of September a remarkable run of the larger fungi rarely seen in other years even at a later period. The Hon. Secretary has to thank Mr. A. D. Cotton, Miss E. M. Wakefield, Mr. J. Ramsbottom, and Dr. J. W. Ellis for their kind assistance in preparing the subjoined list.

COMPLETE LIST OF FUNGI GATHERED DURING THE FORAY.

C. = Cillibion Plantation and Green Cwm; *D.* = Darran Wood, Stanley Wood, and Mountain Pine Wood; *M.* = Smear Moor and Ilston Valley; *S.* = Sketty Park, New Mill and Rhydydefaid Woods.

Amanita rubescens (Pers.) Fr., *D.*, *M.*

Amanitopsis fulva (Schaeff.) W. G. Sm., *D.*

Lepiota excoriata (Schaeff.) Fr., *M.*, gracilenta (Krombh.) Fr., *M.*, alba Bres., *M.*, cristata (A. & S.) Fr., *C.*, granulosa (Batsch) Fr., *M.*, polysticta Berk., *Bishopston Valley*, sistrata Fr. *C.*

Armillaria mellea (Vahl.) Fr., *C.*, *D.*, *M.*, *S.*

Tricholoma albobrunneum (Pers.) Fr., *M.*, rutilans (Schaeff.) Fr., *D.*, *M.*, variegatum (Scop.) Fr., *Mountain Pine Wood*, terreum (Schaeff.) Fr., *S.*, saponaceum Fr., *S.*, carneum (Bull.) Fr., *M.*, grammopodium (Bull.) Fr., *C.*, melaleucum (Pers.) Fr., *M.*

Clitocybe rivulosa (Pers.) Fr., S., infundibuliformis (Schaeff.) Fr., *C.*, fragrans (Sow.) Fr., *C.*

Laccaria laccata (Scop.) B. & Br., *C.*, *D.*, *M.*, *S.*, var. amethystina (Vaill.) B. & Br., *C.*, *D.*, *S.*

Collybia platyphylla (Pers.) Fr., *S.*, fusipes (Bull.) Berk., *C.*, maculata (A. & S.) Fr., *C.*, *M.*, confluens (Pers.) Fr., *C.*, *S.*, dryophila (Bull.) Fr., *C.*, *M.*, atrata Fr. *M.*, ambusta Fr., *C.*, *M.*

Mycena elegans (Pers.) Fr., *M.*, *S.*, pura (Pers.) Fr., *M.*, rugosa Fr., *C.*, *D.*, galericulata (Scop.) Fr., *D.*, *S.*, polygramma (Bull.) Fr., *C.*, alcalina Fr., *C.*, *M.*, atro-cyanea (Batsch) Fr., *D.*, ammoniaca Fr., *S.*, filopes (Bull.) Fr. *C.*, *M.*, virens (Bull.) Quél., *M.*, tenella Fr., *S.*, acicula (Schaeff.) Fr., *Bishopston Valley*, haematopus (Pers.) Fr., *C.*, *S.*, sanguinolenta (A. & S.) Fr., *C.*, *D.*, *M.*, *S.*, galopus (Pers.) Fr., *C.*, *M.*, var. alba Fl. Dan., *C.*, var. nigra Fl. Dan., *C.*, *D.*, epipterygia (Scop.) Fr., *C.*, *D.*, rorida Fr., *C.*, *M.*, tenerrima Berk., *C.*

Omphalia fibula (Bull.) Fr., *C.*, *D.*, *M.*, *S.*, integrella (Pers.) Fr., *C.*

Pleurotus ostreatus (Jacq.) Fr., *C.*

Hygrophorus pratensis (Pers.) Fr., *C.*, *D.*, var. pallidus Cke., *D.*, virgineus (Wulf.) Fr., *M.*, niveus (Scop.) Fr., *M.*, clivalis Fr., *C.*, subradiatus (Schum.) Fr., *M.*, coccineus (Schaeff.) Fr., *M.*, obrusseus Fr., *M.*, conicus (Scop.), Fr., *C.*, calyptraeformis Berk., *M.*, chlorophanus Fr. *M.*, psittacinus (Schaeff.) Fr., *C.*

Lactarius turpis (Weinm.) Fr., *D.*, pubescens Fr., *D.*, pyrogalus (Bull.) Fr., *D.*, vellereus Fr., *C.*, *M.*, quietus Fr., *C.*, *D.*, *S.*, rufus (Scop.) Fr., *M.*, glyciosmus Fr., *D.*, serifluus (DC.) Fr., *C.*, *D.*, subdulcis (Pers.) Fr., *C.*, *S.*, obnubilus (Lasch) Boud., *C.*

Russula nigricans (Bull.) Fr., *C.*, *S.*, rosacea (Pers.) Fr., *C.*, atropurpurea (Krombh.) Maire, *D.*, drimeia Cke., *C.*, *S.*, lactea (Pers.) Fr., *M.*, lepida Fr., *M.*, rubra (Krombh.) Bres., *M.*, vesca Fr., *C.*, *S.*, cyanoxantha (Schaeff.) Fr., *C.*, *D.*, *M.*, *S.*, foetens (Pers.) Fr., *D.*, fellea Fr., *S.*, ochroleuca (Pers.) Fr., *D.*, *S.*, fragilis (Pers.) Fr., *C.*, *S.*, var. nivea (Pers.) Cke., *C.*, *S.*, puellaris Fr., *M.*, lutea (Huds.) Fr., *D.*, *S.*

Cantharellus cibarius Fr., *C.*, *S.*

Marasmius oreades (Bolt.) Fr., *D.*, *M.*

Schizophyllum commune Fr., *S.*

Lenzites betulina (Linn.) Fr., *C.*, *S.*

Pluteus cervinus (Schaeff.) Fr., *C.*, *D.*, ephebius Fr., *C.*

Entoloma nidorosum Fr., *C.*, *D.*

Clitopilus prunulus (Scop.) Fr., *C.*

Leptonia sericella (Fr.) Quél., *M.*, *S.*

Nolanea pascua (Pers.) Fr., *C.*, *M.*, mammosa (Linn.) Fr., *D.*

Eccilia griseorubella (Lasch) Fr., *Bishampton Valley.*

Claudopus variabilis (Pers.) W. G. Sm., *C.*, *S.*

Pholiota terrigena Fr., *S.*, aegerita Fr., *C.*, spectabilis Fr., *S.*, mutabilis (Schaeff.) Fr., *S.*, marginata (Batsch) Fr., *D.*

Inocybe rimosa (Bull.) Fr., *M.*, *S.*, duriuscula Rea, *S.*, fastigiata (Schaeff.) Fr., *M.*, asterospora Quél., *D.*, geophylla (Sow.) Fr., *C.*, *D.*, *S.*

Hebeloma fastibile Fr., *C.*, *D.*, glutinosum (Lindg.) Fr., *S.*, mesophaeum Fr., *C.*, *M.*, crustuliniforme (Bull.) Fr. var. minor Cke. (=hiemale Bres.), *C.*, *D.*

Flammula carbonaria Fr., *M.*, sapinea Fr., *C.*, *D.*

Naucoria melinoides (Bull.) Fr., *M.*, escharoides Fr., *C.*, *S.*

Galera tenera (Schaeff.) Fr., *C.*, *M.*, hypnorum (Schrank) Fr., *C.*, *D.*, *S.*, bryorum (Pers.) Fr., *C.*, *S.*

Tubaria furfuracea (Pers.) W. G. Sm., *C.*, *D.*, *S.*

Crepidotus nidulans (Pers.) Quél., *S.*, mollis (Schaeff.) Fr., *S.*

Cortinarius (Myxacium) elatior (Pers.) Fr., *C.*

(Inoloma) callisteus Fr., *C.*

(Dermocybe) ochroleucus (Schaeff.) Fr., *C.*, tabu-

laris (Bull.) Fr., *S.*, caninus Fr., *M.*, *S.*, azureus Fr., *C.*, *D.*, anomalus Fr., *C.*, lepidopus Cke., *C.*, *S.*, cinnamomeus (Linn.) Fr., *D.*, uliginosus Berk., *C.*

(Telamonia) hinnuleus (Sow.) Fr., *S.*, hemitrichus (Pers.) Fr., *C.*, *D.*, *S.*, rigidus (Scop.) Fr., *C.*

(Hydrocybe) decipiens (Pers.) Fr., *S.*

Paxillus involutus (Batsch) Fr., *C.*, *D.*, panuoides Fr., *D.*

Psaliota campestris (Linn.) Fr., *C.*, *S.*, comtula Fr., *M.*

Stropharia aeruginosa (Curt.) Fr., *C.*, inuncta Fr., *C.*, semiglobata (Batsch) Fr., *C.*, *M.*, *S.*

Hypholoma capnoides Fr., *C.*, *D.*, epixanthum Fr., *C.*, *S.*, fasciculare (Huds.) Fr., *C.*, *M.*, *S.*, velutinum (Pers.) Fr., *M.*, appendiculatum (Bull.) Fr., *D.*, *M.*, *S.*, hydrophilum (Bull.) Fr.

Psilocybe subericaea Fr., *C.*, *M.*, semilanceata Fr., *C.*, *M.*

Psathyra corrugis (Pers.) Fr., *C.*, *D.*, *S.*

Bolbitius fragilis (Linn.) Fr., *S.*, titubans (Bull.) Fr., *C.*, *S.*

Coprinus atramentarius (Bull.) Fr., *C.*, *M.*, cinereus (Schaeff.) Fr., *C.*, *S.*, niveus (Pers.) Fr., *C.*, *D.*, *S.*, micaceus (Bull.) Fr., *C.*, *S.*, radiatus (Bolt.) Fr., *C.*, plicatilis (Curt.) Fr., *C.*, *S.*

Panaeolus sphinctrinus Fr. M., campanulatus (Linn.) Fr., *C.*, *D.*, *S.*, papilionaceus (Bull.) Fr., *M.*

Anellaria separata (Linn.) Karst., *C.*, *M.*, fimiputris (Bull.) Karst., *M.*

Psathyrella gracilis (Pers.) Fr., *C.*, *S.*, atomata Fr., *D.*, *M.*

Gomphidius viscidus (Linn.) Fr., *S.*

Boletus luteus (Linn.) Fr., *M.*, elegans (Schum.) Fr., *D.*, badius Fr., *D.*, *M.*, piperatus (Bull.) Fr., *M.*, subtomentosus (Linn.) Fr., *D.*, luridus (Schaeff.) Fr., *C.*, *M.*, *S.*, scaber (Bull.) Fr., *D.*, *M.*

Fistulina hepatica (Huds.) Fr., *C.*, *S.*

Polyporus squamosus (Huds.) Fr., *M. S.*, nummularius (Fr.) Quél., *S.*, giganteus (Pers.) Fr., *M.*, *S.*, lacteus Fr., *S.*, fragilis Fr., *M.*, *S.*, caesius (Schrad.) Fr., *C.*, *S.*, adustus (Willd.) Fr., *C.*, *M.*, *S.*, betulinus (Bull.) Fr., *C.*, *D.*, *S.*

Fomes applanatus (Pers.) Wallr., *M.*, *S.*, annosus Fr., *C.*, *S.*

Polystictus radiatus (Sow.) Fr., *C.*, versicolor (Linn.) Fr., *C.*, *D.*, *M.*, *S.*

Poria mucida (Pers.) Fr., *C.*, *D.*, sanguinolenta (A. & S.) Fr., *C.*, *D.*, hymenocystis B. & Br., *C.*, *S.*

Trametes rubescens (A. & S.), Fr., *C.*, *D.*, *M.*, *S.*

Daedalea quercina (Linn.) Fr., *C.*, *S.*

Merulius lacrymans (Wulf.) Fr., *Swansea*, papyraceus Fr., *S.* (new to Britain).

Hydnum repandum (Linn.) Fr., *C.*, udum Fr., *C.*, *M.*, *S.*
Sistotrema confluens (Pers.) Fr., *C.*
Irpex obliquus (Schrad.) Fr., *C.*, *D.*, *M.*, *S.*
Phlebia merismoides Fr., *C.*, *S.*, radiata Fr., *Bishopston Valley.*
Grandinia mucida Fr., *M.*, granulosa Fr., *Bishopston Valley*, *D.*
Odontia fimbriata (Pers.) Fr., *C.*, *S.*, farinacea (Pers.) Quél., *C.*, *D.*, *S.*, fusco-atra (Fr.) Bres.
Thelephora laciniata (Pers.) Fr., *C.*
Stereum hirsutum (Willd.) Fr., *C.*, *D.*, *M.*, *S.*, purpureum (Pers.) Fr., *C.*, sanguinolentum (A. & S.) Fr., *C.*, rugosum (Pers.) Fr., *C.*, *D.*, *M.*, *S.*
Hymenochaete rubiginosa (Schrad.) Lév., *M.*, tabacina (Sow.) Lév., *C.*
Corticium Sambuci (Pers.) Fr., *C.*, subcoronatum v. H. & L., *S.*, praetermissum (Karst.) Bres., *C.*, confine Bourd. & Galz., *C.*
Peniophora quercina (Pers.) Cke., *Crawley Woods*, *C.*, *M.*, *S.*, cinerea (Fr.) Cke., *S.*, hydnoides Cke. & Mass., *C.*, *M.*, *S.*, velutina (DC.) Cke., *S.*, glebulosa Bres., *C.*, *D.*, setigera (Fr.) Bres., *C.*, *S.*, pubera (Fr.) Mass., aurantiaca Bres., *C.*, longispora (Pat.) v. H. & L., *C.*, subalutacea (Karst.) v. H. & L., *C.*, *S.*, byssoidea (Pers.) v. H. & L. (=Corticium lacunosum B. & Br.), *M.*, *on Pinus.*
Tomentella caesia (Pers.) v. H. & L., *Crawley Woods*, fusca (Pers.) v. H. & L., *C.*, *D.*, *S.*, subfusca* (Karst.) v. H. & L., *C.* (new to Britain).
Coniophora puteana (Schum.) Fr., *D.*
Cyphella capula (Holmsk.) Fr., *C.*
Solenia anomala (Pers.) Fr., *C.*
Clavaria muscoides (Linn.) Fr., *S.*, cinerea (Bull.) Fr., *S.*, cristata (Holmsk.) Fr., *C.*, *S.*, rugosa (Bull.) Fr., *S.*, Kunzei Fr., *M.*, stricta (Pers.) Fr., *M.*, fusiformis (Sow.) Fr., *D.*, *S.*, vermicularis (Scop.) Fr., *S.*
Typhula erythropus (Bolt.) Fr., *C.*
Pistillaria quisquiliaris Fr., *C.*
Auricularia Auricula-Judae (Linn.) Schröt., *C.*, mesenterica Fr., *Oxwich.*
Sebacina incrustans Tul., *S.*
Tulasnella incarnata† Juel., *D.* (new to Britain).
Exidia recisa (Ditm.) Fr., *M.*
Ulocolla foliacea (Pers.) Bref., *M.*
Femsjonia luteoalba Fr., *C.*, *D.*, *M.*, *S.*
Tremella mesenterica (Retz.) Fr., *C.*, *S.*, albida (Huds.) Fr., *M.*, *S.*

* For description see p. 253.

† For description see p. 254.

Dacryomyces deliquescens (Bull.) Duby, *S.*, stillatus (Nees) Fr., *C.*, *S.*
Calocera cornea (Batsch) Fr., *D.*, stricta Fr., *M.*, *S.*
Cyathus striatus (Huds.) Pers., *C.*
Crucibulum vulgare Tul., *C.*
Bovista plumbea Pers., *D.*, *S.*, nigrescens Pers., *C.*, *S.*
Lycoperdon depressum Bon. *Bishopston Valley*, caelatum (Bull.) Fr., *M.*, pyriforme (Schaeff.) Pers., *M.*, *S.*, umbrinum Pers., *M.*
Scleroderma verrucosum (Bull.) Pers., *M.*
Uromyces Limonii (DC.) Lév. *Oxwich Marshes, on Statice Limonium.*
Puccinia Violae (Schum.) DC., *C.*, Lychnidearum Link *C.*, Circaeae Pers., *C.*, Pimpinellae (Str.) Mart., *S.*, Valantiae Pers., *C.*, *on Galium Cruciata*, obtegens (Link) Tul., *M.*, Glechomatis DC., *C.*, Menthae Pers., *C.*, *D.*, *M.*, *S.*, Poarum Niels., *D.*, *M.*, *S.*
Phragmidium Fragariastri (DC.) Schröt., *M.*, mucronatum Schlecht., *M.*, albidum (Kühn.) Ludw., *C.*, violaceum (Schultz.) Wint., *D.*, *S.*
Coleosporium Senecionis (Pers.) Fr., *M.*
Melampsora Hypericorum (DC.) Schröt., *C.*, *S.*, *on Hypericum Androsaemum.*
Melampsoridium betulinum (Pers.) Kleb., *C.*, *D.*, *M.*, *S.*
Urocystis Anemones (Pers.) Wint., *C.*, *on Ranunculus repens.*
Sphacelotheca Hydropiperis (Schum.) de Bary, *C.*
Sphaerotheca pannosa (Wallr.) Lév., *C.*, *S.*, Castagnei Lév., *M.*
Erysiphe Cichoracearum DC., *Crawley Woods, on Arctium*, Galeopsidis DC., *M.*
Phyllactinia suffulta (Rebent.) Sacc., *D.*
Nectria cinnabarina (Tode) Fr., *S.*, episphaeria (Tode) Fr., *C.*, coccinea (Pers.) Fr., *C.*
Hypomyces aurantius (Pers.) Tul., *C.*, *S.*, rosellus (A. & S.) Tul., *S.*
Cordyceps militaris (Linn.) Link, *D.*
Leptospora spermoides (Hoffm.) Fckl., *D.*
Stigmatea Ostruthii (Fr.), *M.*
Leptosphaeria Typharum (Desm.) Karst., *Oxwich Marshes, on Typha.*
Pleospora herbarum (Pers.) Rabh., *C.*, *D.*
Diaporthe rostellata (Fr.) Nke., *C.*
Eutypa lata Tul., *D.*
Valsa ceratophora Tul., *S.*
Melanconis stilbostoma (Fr.) Tul., *C.*, *D.*, *S.*
Pseudovalsa lanciformis (Fr.) Ces. & de Not., *D.*
Diatrypella quercina (Pers.) Nke. *C.*, *D.*, *M.*, *S.*
Diatrype stigma (Hoffm.) de Not., *C.*, disciformis (Hoffm.) Fr., *C.*, *S.*

Hypoxylon multiforme Fr., *D.*, fuscum (Pers.) Fr., *C.*, *M.*, *S.*, coccineum (Bull.) Fckl., *M.*, *S.*
Daldinia concentrica (Bolt.) Ces. & de Not., *S.*
Ustulina vulgaris Tul., *C.*
Xylaria hypoxylon (Linn.) Grev., *C.*, *D.*, *S.*
Phyllachora Graminis (Pers.) Fckl., *C.*, *D.*, *S.*, Junci (Fr.) Fckl., *C.*, Angelicae (Fr.) Fckl., *C.*, *M.*
Dothidella betulina (Fr.) Sacc., *C.*, Ulmi (Duv.) Wint., *M.*
Helvella crispa (Scop.) Fr., *C.*, *M.*
Galactinia badia (Pers.) Boud., *D.*
Peziza aurantia Pers., *S.*
Lachnea hemisphaerica (Wigg.) Gill., *D.*
Ciliaria scutellata (Linn.) Quél., *C.*
Cheilymenia dalmeniensis (Cke.) Boud., *D.*, stercorea (Pers.) Boud., *S.*
Humaria humosa (Fr.) Sacc., *M.*
Coprobia granulata (Bull.) Boud., *C.*, *M.*
Ascobolus stercorarius (Bull.) Schröt., *D.*
Pyronema omphalodes (Bull.) Fckl., *S.*
Geoglossum ophioglossoides (Linn.) Sacc. (syn. glabrum) *Bishopston Valley.*
Leotia lubrica (Scop.) Pers., *C.*, *D.*
Cudoniella acicularis (Bull.) Schröt., *D.*, *S.*
Ombrophila clavus (A. & S.) Cke., *D.*, *S.*, nigripes (Pers.) Boud., *C.*
Calycella citrina (Hedw.) Quél., *C.*
Coryne sarcoides (Jacq.) Tul., *C.*, *M.*, *S.*
Bulgaria inquinans (Pers.) Fr., *C.*, *S.*
Corynella atrovirens (Pers.) Boud., *D.*
Orbilia xanthostigma Fr., *S.*
Sclerotinia Curreyana (Berk.) Karst., *C.*, *Sclerotium roscum* Fr.
Phialea firma (Pers.) Gill., *M.*
Chlorosplenium aeruginosum (Oeder.) de Not, *C.*, *M.*
Helotium herbarum (Pers.) Fr., *C.*, fructigenum (Bull.) Fckl., *C.*, *D.*, *S.*, virgultorum (Wahl.) Karst., *C.*, *S.*
Dasyscypha virginea (Batsch) Fckl., *C.*, *D.*, *S.*, nivea (Hedw. fil.) Sacc., *D.*, *M.*, *S.*
Trichoscypha calycina (Schum.) Boud., *D.*
Hyaloscypha hyalina (Pers.) Boud., *M.*
Mollisia cinerea (Batsch) Karst., *C.*, *D.*, *S.*, melaleuca (Fr.) Sacc., *M.*, *S.*
Hypoderma virgultorum DC., *C.*
Lophodermium Pinastri (Schrad.) Chev., *M.*
Rhytisma acerinum (Pers.), Fr., *C.*, *D.*, *M.*, *S.*, punctatum (Pers.) Fr.
Pilobolus crystallinus (Wiggers) Coem., *M.*
Syzygites megalocarpus Ehrenb., *M.*

Phoma conigena Karst., *C.*, herbarum Westend, *C.*, Urticae Schulz. & Sacc., *M.*, samaricola Sacc., *M.*, cylindrospora (Desm.) Sacc., *D.*
Cytospora Lauro-cerasi Fuck., *C.*, Salicis (Cda.) Rabenh., *M.*
Ceuthospora Lauri Grev., *C.*, phacidioides Grev., *C.*, *D.*
Septoria Fragariae Desm., *C.*, Paeoniae Westend. *Gower Inn garden, on Paeonia*, Hederae, Desm., *C.*
Phleospora ulmicola (Biv. Bern.) Alles., *C.*, *M.*
Marssonia Populi (Libert) Sacc., *C.*
Oidium alphitoides Griff. & Maulb., *D.*, *M.*
Monilia aurea Gmel., *S.*
Trichoderma lignorum (Tode) Harz., *S.*
Sepedonium chrysospermum (Bull.) Fr., *S.*
Ovularia obliqua (Cke.) Oud., *C.*, *M.*
Botrytis cinerea (Pers.) Fr., *D.*, var. sclerotiophila (Rabenh.) Sacc., *D.*, *on dead capsules of Scilla non-scripta.*
Ramularia Primulae v. Thüm., *C.*, calcea (Desm.) Ces., *C.*, *S.*, *on Nepeta.*
Cladosporium herbarum (Pers.) Link, *C.*
Cercospora Mercurialis Pas., *C.*, *M.*
Bispora monilioides Cda., *C.*, *D.*, *S.*
Stilbella erythrocephala (Ditmar) Lindau *C.*, fimetaria (Pers.) Lindau, *S.*
Tilachlidium tomentosum (Schrad.) Lindau, *D.*
Isaria farinosa (Dicks.) Fr., *D.*, arachnophila (Ditm.) Link., *S.*
Bactridium flavum Kze. & Schum., *C.*

MYCETOZOA
FOUND IN THE GOWER PENINSULA, SEPTEMBER 19 to OCTOBER 2, 1915.

By Gulielma Lister, F.L.S.

The following list of Mycetozoa includes the species found during the Swansea Foray in expeditions taken in the south-east of the Gower Peninsula, and also those obtained by two of the members during the previous week in the neighbourhood of Llangennith, at the extreme north-west of the Peninsula.

In the latter district four types of hunting ground favourable for Mycetozoa presented themselves, viz., mixed woods of oak, ash, sycamore, and a few larches; heaps of hedge clippings; dead stems of gorse and bramble lying under the shelter of a stone wall, among grass and bracken; and old straw heaps spread around a cluster of stacks in a meadow.

The first expedition of the Swansea Foray, September 28th, was to the mixed woods and park-land of Sketty Park and the Clyne Valley. Almost continuous rain was unfavourable to collecting many Mycetozoa, but twelve species were obtained. September 29 was fine, with showers. We were conducted across Smear Moor to a plantation of young oak, birch, spruce, and Scotch fir; thence over moorland by Saint Iltyd Church to Carey's Wood, and on to Gower Inn. On September 30, a brilliant day, our hunting grounds lay east of Gower proper, in a series of steep, mixed woods, Darran Wood, Stanley Wood and Mountain Pine Wood, near Skewen. On October 1 we visited Cillibion Plantation, a moist wood of oak, ash, and alder, with scattered pine and spruce, and with undergrowth of rhododendron and bramble, the whole intersected by broad grass rides; later we strolled down Green Cwm and searched the woods of oak and ash on its slopes. This was by far our most favourable day, both for Fungi and Mycetozoa.

In the accompanying list of the species of Mycetozoa that were observed, the districts in which they were found are indicated by the following abbreviations:—*L.* = Llangennith; *S.* = Sketty Park and Clyne Valley; *M.* = Smear Moor and Carey's Wood; *D.* = Darran and Stanley Wood; *C.* = Cillibion Plantation and Green Cwm.

Ceratiomyxa fruticulosa (Muell.) Macbr. *L.* On fallen oak boughs.

Badhamia utricularis (Bull.) Berk. *M., C.* Plasmodium only found creeping over *Corticium* sp.

B. panicea (Chev.) Rost. *C.* On dead ivy stems.

Physarum nutans Pers. *L., S., M., D., C.* Very abundant on dead wood.

P. viride (Bull.) Pers. *L.* On fallen oak bough.

P. pusillum (Berk. & Curt.) Lister. *L.* On hedge clippings.

P. bitectum Lister. S. On dead holly leaves.

P. cinereum Pers. *L., C.* On dead thistles, nettles and old straw.

Fuligo septica Gmel. *L., D.* A few weathered aethalia only seen.

Craterium minutum (Leers) Fries. *L., C.* On straw, leaves and twigs.

Leocarpus fragilis (Dicks.) Rost. *C.* Found in yellow plasmodium which matured into sporangia indoors.

Diderma hemisphericum (Bull.) Hornem. *L.* Very abundant on hedge clippings.

D. effusum (Schwein.) Morgan. *C.* On dead leaves.

Diachaea leucopoda (Bull.) Rost. *C.* On dead leaves and twigs.

Didymium difforme (Pers.) Duby. *L.* Abundant on old straw, hay and hedge clippings.

D. complanatum Rost. *L.* On dead bracken stalks among grass.

D. squamulosum (Alb. & Schw.) Fries. *L., S., D.* On straw and dead leaves.

D. Clavus (Alb. & Schw.) Rost. *L.* On hedge clippings.

D. nigripes Fries. *S., C.* On holly leaves and pine twigs. Var. *xanthopus* Lister. *L., D.* On dead leaves.

D. melanospermum (Pers.) Macbr. *M., C.* On pine needles and twigs.

Mucilago spongiosa (Leyss.) Morgan. *L., C.* On old straw and dead leaves.

Stemonitis fusca Roth. *L., S., M., C.* On dead wood. Var. *confluens* Lister. *D.* A large growth with very irregular columellae was found on a stump.

S. flavogenita Jahn. *L., S., C.* On dead wood and leaves.

S. ferruginea Ehrenb. *C.* On dead wood.

S. splendens Rost., var. *flaccida* Lister. *S.* A weak form with very slender columellae.

Comatricha nigra (Pers.) Schroet. *L., S., M., D.* Abundant on dead twigs.

C. laxa Rost. *L., M.* A robust form with cylindrical sporangia was obtained on old gorse and other twigs.

C. pulchella (Bab.) Rost. *D.* On dead oak leaves, mouldy.

Lamproderma scintillans (Berk. & Br.) Lister. *L.* On hedge clippings.

L. arcyrionema Rost. *L.* On dead wood. This is the first time the species has been obtained on our forays, and is a new record for Wales. Although widely distributed throughout the Old and New worlds, *L. arcyrionema* is not common in the British Isles. In England it has been obtained in Middlesex, Essex, Bedfordshire, Sussex, Norfolk, Yorkshire, Herefordshire, and Cornwall. It has not yet been recorded for Scotland or Ireland.

Enerthenema papillatum (Pers.) Rost. *L.* On fallen oak branches.

Cribraria rufa (Roth.) Rost. *L.* On a prostrate larch.

Dictydium cancellatum (Batsch) Macbr. *L.* On dead wood.

Reticularia Lycoperdon Bull. *D., C.* Two aethalia were found on stumps.

Lycogala epidendrum (L.) Fries. *L., S., C.* On stumps.

Trichia affinis de Bary. *L.* On dead wood.

T. verrucosa Berk. *D.* A single small gathering of this uncommon species was made on dead wood.

T. persimilis Karsten. *L., S., C.* Fairly abundant on dead wood.

T. decipiens (Pers.) Macbr. *L., D., C.* On stumps.

T. Botrytis Pers. *M., D.* On fallen boughs of oak and pine.

Hemitrichia clavata (Pers.) Rost. *C.* On dead wood.

Arcyria cinerea (Bull.) Pers. *L., S., M., D., C.* Abundant on dead wood, sometimes on dead leaves.

A. pomiformis (Leers) Rost. *L., S., M., D.* Remarkably abundant on fallen oak boughs.

A. incarnata Pers. *L., M.* On dead oak wood.

A. denudata (L.) Sheldon. *L., M.*

A. nutans (Bull.) Grev. *L., M., D., C.* Abundant; in one case large tufts of the mature yellow sporangia were found on a decayed oak branch still attached to the tree, and several feet from the ground.

Perichaena corticalis (Batsch) Rost., *C.* On dead wood.

Although no specimen of very striking interest was collected, this list of 47 species compares well with those obtained on our previous forays. Wrexham, in 1910, gave us 44 species of Mycetozoa; Taunton, in 1911, a very dry year, 27 species; Haslemere, in 1913, 42 species; Doncaster, in 1911, 36 species. The only list that exceeds it is our remarkable Forres record, in 1912, of 81 species.

PRESIDENTIAL ADDRESS.

By Emma Amy Rea.

NOTES ON FUNGUS ILLUSTRATIONS.

It was with great reluctance that I consented to accept your kind election to the Presidentship for this year. I am conscious that I do not possess that knowledge of our Fungi which should alone qualify a member for that post. This being the case I suppose that you have elected me to this position in consideration of the work I have done in illustrating some of the more important additions to our larger British Fungi, which have appeared in some of the past Transactions of our Society. Up to the present time I have painted over fifteen hundred original drawings of British Fungi, and many of these include additions to the British Flora, some new to Science, and others which have no satisfactory published illustrations. I have mainly confined myself to illustrating the Basidiomycetes and Discomycetes, because it is only when these are dealt with in a fresh growing condition that one can execute paintings that will represent them, as we know them in the field. Dried and spirit collections of these to my mind are absolutely useless, with the exception of some microscopical details, and these again are much more reliable when obtained from mature fresh specimens. Ordinary photographs are insufficient, as we lose so much by the absence of colour, and the smaller species become dwarfed beyond recognition. My greatest interest has centred in our Macrofungi, and I propose in this address to draw your attention to the existing published illustrations that more especially represent this group, and I shall deal with them in chronological succession.

The first known illustration of Fungi was found at Herculaneum and Pompeii, when these cities were excavated, after they had been buried in lava and ashes by the eruption of Mount Vesuvius in A.D. 79. A great number of Frescos were found, and one illustration of Fungi amongst them. Comes, who wrote the book on the plants depicted at Pompeii, has identified the fungus as *Lactarius deliciosus*.

The next illustration is a Fresco painted at the end of the thirteenth century (1291), and occurring on a disused chapel situated opposite the Castle of Plaincourault, between

Ingrandes and Mérigny, in front of the Val de L'Anglais (Indre). This Fresco, which is six hundred years old, is well enough preserved to have been reproduced by photography. It represents Eve by the side of the Tree of Good and Evil, this tree being represented under the form of an extraordinary fungus, in which one can recognise *Amanita muscaria.* Round about it is twined the traditional serpent, in the act of offering Eve the apple. The artist had evidently found a difficulty in finding a tree bearing good and evil fruits, so he was struck with the happy idea of depicting it as a fungus, his imagination aiding him and our "beautiful red fungus," to which our attention is so often drawn, inspiring him. The pileus is spotted as in nature, but, contrary to nature, he has drawn the fungus branched, with numerous undeveloped pilei. Poor Eve has evidently tasted of the forbidden fruit and seems to be suffering in consequence. The illustration is reproduced in the Bulletin de la Société Mycologique de France, xxvii., t. xxvii., 31.

1601. One of the earliest illustrators of Fungi was Clusius (de l'Ecluse), born at Arras in 1526. In his Rariorum Plantarum Historia he wrote a separate treatise on the Fungi of Pannoi, a province on the south of the Danube, illustrated by thirty-two wood-cuts, all original except three, which are copied from Dodoens (1583), his friend who allowed their reproduction. Clusius was in 1593 called to Leyden, and there appointed Professor of Botany.

The drawings are extremely good. I noticed amongst them *Polyporus squamosus*, most carefully done, but unfortunately the characteristic black stem is cut off, and there is no section. Tab. 54 must surely be *Boletus pinicola.* Tab. 58 a rather dried specimen of *Lepiota procera.* Tab. 59 a *Boletus* which apparently has pink spores, but this is more likely to be the effect of a *Hypomyces.* Tab. 64 a *Lactarius* with red milk, perhaps *deliciosus.* Tab. 71 undoubtedly *Lactarius deliciosus.* Another plate a magnificent example of *Polyporus intybaceus* or *frondosus.* Table 72 a group of *Hypholoma hydrophilum.* Tab. 75 a peziza *Sarcoscypha coccinea.* Tab. 58 a Puff-ball in a young state, with the shadows beautifully put in. Tab. 78 *Collybia fusipes*, extremely good, the characters are so well caught. Tab. 80 *Russula sardonia*, with the gills turning rather yellow. Tab. 83 *Hydnum erinaceum.* Tab 84 probably *Hypholoma fasciculare.* Tab. 86 a *Polyporus* with no section or pores. There are also in existence at the Leyden library a collection made by Clusius of eighty-three water-colour drawings of Fungi, which have recently been published by Istvánffi to celebrate the tricentenary of Clusius. Many of these were included in his original work.

1650—1651. Johanne Bauhin. Historia plantarum universalis. These are black and white engravings illustrating a few Agarics, Clavariae, Amanitae, Boleti, and a Morel, and there is a *Phallus* which looks rather like *impudicus*. He was one of two brothers, the sons of John Bauhin. His drawings of Fungi are mostly reduced copies of those of Clusius.

1675. Van Sterbeeck, a Flemish priest who worked at Fungi for twenty years before publishing his Theatrum fungorum in 1675. He was dependent upon the work of Clusius, and more than two-thirds of his copper-plate engravings seem to have been copied from Clusius' paintings.

These illustrations are crude but recognisable. I should think he was playing a prank with his illustration tab. 29. His *Polyporus intybaceus* or *frondosus* is very good.

How important colour is in the representation of Fungi.

1727. Sebastian Vaillant's Botanicon parisiense, illustrated in black and white, is very careful work. One can recognise Earth-tongues, Clavariae, Nidulariae, Peziзae, *Cantharellus cibarius*, various agarics, puff balls, *Coprinus atramentarius* and *Scleroderma vulgare*.

1729. P. A. Micheli. Nova Plantarum Genera. Containing one hundred and eight plates uncoloured line drawings mostly of cryptogams. These drawings shew microscopic details, *e.g.*, spores in fours in *Coprinus* and enclosed in asci in *Tuber*. They are rather formal but excellent in mass of detail for 1729.

1750. J. Antonius Battarra illustrated his Fungorum Agri Ariminensis Historia with forty plates. These are copper-plate engravings and uncoloured. The drawing is hard and wooden but very careful work; the want of colour makes them most difficult to identify. Tab. XI. we can identify, although not coloured as *Armillaria mellea*. This is rather strange, as so many of us find it difficult to identify this fungus in the field.

Tab. VII., fig. B, the mycelium and growth of young mushrooms underground is beautifully shewn.

Tab. XXVII. *Psathyrella disseminata* and other groups of Coprini very prettily drawn. There are delineated Clavariae, Geasters, Boleti, and Polypori. The Nidularieae are nicely worked out, showing the funiculus by which the "eggs" are attached to the inside of the outer peridium wall. All well painted by the artist Neandre for Battarra. My best thanks are due to Mr. Swanton for his generous gift of this book to us. The frontispiece is very interesting with the Lynx, representing the most Holy Roman Empire, with its fore paw resting on a fungus, dominating it as it would everything else if it could; and an owl—wisdom, I suppose—is surrounded by

them in one corner, in the other corner is a tree bearing a hoof-shaped *Polyporus igniarius*.

1753. Gleditsch, Methodus Fungorum. This gentleman drew on his imagination considerably, and produced black and white geometrical drawings of Clavariae, Morchellae, Helvellae, Lycoperdons, Geasters (the last he called Lycoperdons), and a few Morels, one of which looks much like a mycetozoon.

1762—1774. Our next illustrator is the famous Jacob Christian Schaeffer. His Fungorum Icones representing the Fungi of Bavaria and the country around Ratisbon, is very careful and accurate work. The illustrations are copper-plate and have a wooden appearance, but I think this is generally the case when plates are engraved and then coloured afterwards, and I should dearly like to have seen his original paintings. He advances a great step beyond the former illustrators, as he inserts sections, spore maps and spores on his plates. In the four volumes of his work there are three hundred and thirty plates, many of them of the ordinary common run of Fungi which seem to occur generally in most countries. At any rate these Bavarian Fungi are what would strike the eye of the casual observer in our woods. Then there are a few rarer kinds which he would have come across himself or which may have been brought to him for identification by other observers. On several plates, unknowingly probably, he has represented two kinds of Fungi, evidently taking them for other forms of the same as Plate II. *Hygrophorus conicus*, figures 1 and 6, I am sure are another Hygrophorus. The blackening of conicus is well shewn. There are several plates representing the same fungus in different stages of development, such as *Coprinus comatus*. The "nice red fungus," *Amanita muscaria*, plate XXVII., has been duly painted by him, but he, too, has been puzzled like others of us to include its size in the capacity of his plate, and so he reduced it, but it is very good.

Some of the Cortinarii are beautifully done, and one can feel that he had the true scientific spirit combined with the artistic which is so necessary in order to be of use in one's generation as well as for the future ones. The white fungi seem to have puzzled him to paint, and they are most difficult to execute when you endeavour to give the surface and consistency of the plant. I sympathise with him over it. Take one instance of this, *Hygrophorus eburneus*, t. 39, the shining surface and the transparent consistency of the plant is most difficult to portray. Another instance of this is in plate 78, *Clitopilus prunulus*, dead white with delicate pink gills, and yet one has to get the form. It is most difficult to me. When one gets magnificent gorgeous colouring and bold form, like

in *Boletus luridus*, one has something definite to take hold of and all is plain sailing, but these indefinite forms and plain surfaces are most puzzling. Schaeffer's plates at first strike one as crude and hard, but after a little while one learns to appreciate them and to realise their beauty and accuracy, and then one is astonished at the stride that was taken in fungus study by him. What a nice engraving of *Clathrus cancellatus* there is on the title page of volume IV., and what darling little loves there are all busy looking for Fungi in the frontispiece of volume II., and there is a curious frontispiece also to volume I., with a woman, which is I think some embodiment of one of the Indian goddesses. The colouring of the plates on the whole is extremely good, but he has found a difficulty, as we all have, in getting the colour of *Cantharellus cibarius:* spores he calls pollen, and in *Geoglossum hirsutum* he has not found out that there are asci surrounding his spores, doubtless due to the low powers of the microscope that were then available.

1783. Batsch, Elenchus Fungorum. His illustrations are etched and hand coloured. There are a few sections, but no spores. The drawing is careful, the colouring by no means crude, but on the whole rather primitive, and the species most beautifully mixed up. I think this occurred from the plates having been published in parts, and therefore the new species were inserted on one plate, as ours are. I think the small Mycetoza and Sphaeriaceae are the best depicted.

1790—1798. Bulliard. Histoire des Champignons de la France. Although very hard and inartistic, these coloured illustrations are extremely interesting, the artist having caught, if one may so express it, the spirit of the fungus. Bulliard's figures are much quoted, and have provided a foundation for the correct naming of many of our Fungi, but a beginner would be simply bewildered by the names.

In these figures there are sections but the spores are not given.

In plate 76 *Collybia fusipes* is depicted in all its stages, an example to all of us of the importance of the illustration of a fungus in all its life stages, as in this fungus the colours alter so much when the plant ages. The tapering of the stipe at the base is beautifully shewn, and is very distinctive. Plate 106 is the same fungus, but lacks the rich red colour we know so well in *Collybia fusipes*. It seems strange to see the Nidularieae under the name of Peziza, but the plates of them are extremely good. The three species are depicted in all stages of development from extreme youth to maturity.

I wonder how many people would recognise our edible mushroom in plate 134, the only one the prejudiced British generally

condescend to eat, with the exception of the gypsies, who eat Blue-legs and Blue-hats. Plate 142 must be I think the St. George's mushroom *(Tricholoma gambosum)* as the "saveur" is described as "très agréable."

Plate 154 pleases me very much, as it shews a *Peziza* furiously discharging its spores. *Nyctalis parasitica* on the old blackened fungus is fine. *Hydnum repandum* is most careful work.

Plate 60, *Boletus edulis*, but without the distinguishing reticulations on the stype.

Plate 62, Chanterelle, one of the plates that repels one's artistic sense, it is so hard and the colour so incorrect, the gills lack the roundness of the *Cantharellus cibarius* gills, which are more like veins.

I wish we could find plate 120, *Amanita Caesarea*, in England. Plate 178 is a marvellous group. Plate 206 is a good illustration of *Coprinus picaceus*—in all its stages, a perfect sequence from babyhood to old age—an example for all to follow. Plate 218, with what care this Morel is drawn and how strange to find it under the name *Phallus*.

Plate 242, *Helvella elastica;* the colour is poor, but the spores are floating upwards in the loveliest way.

Plate 246, a beautiful group of *Coprinus micaceus*. Of course Bulliard, like the rest of us, could not depict the glittering micaceous granules; that and the smell is, unfortunately, beyond the power of the artist to illustrate. Plate 250, a beautiful painting of *Cortinarius violaceus;* again we see an instance of a fungus depicted in all its stages. Plate 256, *Collybia tuberosa*. How well our old artist has drawn this fungus; the characteristic small tubers have evidently delighted him, and he has depicted them again and again from the smallest to the largest. Plate 294, *Tulostoma brumale*, beautifully drawn. This fungus was found by us in France when accompanied by Monsieur Boudier. Plate 328, how good the name "Le Bolete marron" is for *Boletus castaneus*, it so exactly describes it, the colour being just like that of a ripe chestnut. Plate 330, a *Volvaria* depicted in all its life stages. Plate 392 is an extremely good drawing of *Hypholoma appendiculatum;* the colouring of it is perfect. Plate 434, the character of *Collybia dryophila* is beautifully shewn, altogether a fine plate. Plate 441, *Clathrus cancellatus*. What a good painting this is. I wish I could see this fungus in all its glory. I have only once seen a dried one, at Epinal, when we were with the French Mycological Society in the Vosges. Will not some one send me one to paint? Plate 481, *Hydnum auriscalpium*, beautifully shewn, on its own little Pine cone. I was much delighted when we found our first one of this fungus, and hastened to paint it.

I have only commented on a few of these plates, their beauty has grown on me as I have turned them over. The carefulness of them is above all praise, and one gets over the hardness of them caused no doubt by the reproduction and the hard black lines of the engraving. We must all remember that many of these plates were executed during the frightful period of the French Revolution. Bulliard was not deterred by the excitement of the times from continuing his scientific investigations, and so left to posterity his valuable work. Why should we discontinue our work during this present war? If we do so, our work will be lost to posterity and no good will be gained by a gloomy brooding over this awful war. Let us all work at what seems best fitted to us.

1782-83. V. Bischoff. I have had the pleasure of examining seventeen plates of Bischoff's. Amongst them are some perfectly beautiful ones of Geasters in all stages of development, some with spores and sections and the threads shewn with the spores attached. The other plates of Fungi are not so good; for example, *Coprinus comatus*, which is very wooden and crude. I daresay Miss Lister knows his plates of Myxomycetes, in which a lovely *Cribraria* is drawn on one plate and named "*Clathrus*." Bischoff's drawings are in Schmidel's Icones plantarum, etc., Neuremburg 1747, the second edition of which was made under the care of V. Bischoff 1782-83.

1785. J. Dickson. Plantae cryptogamae Britanniae, containing twelve plates of Fungi. Plate 3 is exceptionally good and contains the well-known drawings of *Myriostoma coliforme*, *Cordyceps entomorrhiza*, and *Pilobolus*. There is a good drawing of *Mitrula* on plate IX.

1788—1791. J. Bolton, History of Fungusses, Halifax. One of our earliest English illustrators of Fungi. These are most curious old etched plates, coloured by hand, wonderfully done for the time at which they were executed and very much quoted. From an artistic point of view they are of small moment, and I confess make me shudder. They have been copied by a German, named Willdenow, and the crudity of the original hand colouring is much more emphasised.

Bolton's names are very quaint. One fungus is named "The Mourning agaric," another the "Font agaric," another the "Pleasing agaric," and another the "Domestic agaric," about which I think there has been much controversy. The "Bundled agaric" is fine, and I suppose represents *Hypholoma fasciculare*. In tab. 63 *Laccaria laccata* var. *amethystina* is depicted in all its glory. I like the way Bolton heads his book, "History of Fungusses." I so often am asked if it is correct to call them fungi or funge, and this gets one out of the difficulty so well. I like also the "Frothy Mould," tab.

134. Tab. 142 is aptly named the "Velvet-stalked Agaric" *(Collybia velutipes)*, and translates the trivial Latin name into sensible English. He drew on his imagination in tab. 130, drawing *Elaphomyces granulatus* with a sort of volva at its base. Perhaps this was only the husk that was left of the tuber. Bolton inserted sections but no spores.

1790-91. Henry Julius Tode, Fungi Mecklenburgenses selecti. Black and white drawings, Sphaerias, Moulds, Myxomycetes, etc. Tode was one of the first to illustrate accurately the details of our microscopic Fungi. Many of his illustrations are quoted at the present day in modern descriptions.

1793. J. J. Paulet, Traité des Champignons. His plates are described by Léveillé. They are careful work for the time, but I consider many of them are very crude and unlifelike and would hesitate much in naming them.

1798—1828. C. H. Persoon, Icones et Descriptiones Fungorum minus Cognitorum, Icones Pictae Rariorum Fungorum 1803-6, and Mycologia Europaea 1822-1828. These are a series of copper plates coloured by hand. Many of them are wooden and unrecognisable, but some are very good, and all shew very careful work. There are a good many Agarics depicted, Sphaerias, Polypori, Hydnums, Nectrias, Clavarias, Pezizas, some Myxomycetes, and other forms of Fungi, with sections. In his Icones pictae, plate IV., f. 1-2, is a very good representation of *Polyporus picipes*, and plate VI. is an excellent one of *Polyporus rufescens*.

In his Icones et Descriptiones, tab. I., fig. 10, he has represented spores and an ascus, and in his other works he also occasionally does this. Tab. III., fig. 5, is a well drawn *Clavaria formosa;* fig. 3, *Cantharellus cinereus* and *Clavaria striata*. Tab. IV., figs. 1-3, is carefully drawn, *Marasmius fuscopurpureus*, and fig. 7, *Flammula sapinea*. Tab. V., figs. 5-7, *Leotia circinans* well worked out. Tab. VII., figs. 1-2, *Epichloe typhina*, beautifully drawn. Tab. X., fig. 1, is a beautiful drawing of *Aecidium crassum* Pers.=*Puccinia coronata*, the little cups are beautifully shewn sitting on the stem of the plant. Tab. XIII., figs. 1-3, is a very life-like painting of *Gomphidius viscidus*. It is beautifully drawn and coloured. The plates in Mycologia Europaea are very carefully drawn and well coloured.

1800. M. Theodor Christian Ellrodt Schwamm-Pomona. These are reduced printed illustrations coloured, with some sections, and the underside of pileus shewing the gills. They are really very nice.

1797—1815. James Sowerby. English Fungi. Some of these coloured illustrations are beautiful and display very careful work, but some are extremely crude. There is great

inequality in the work. He was one of the first Englishmen who adequately published illustrations of British Fungi, but it is a curious fact that many of his original drawings do not agree with the published plates. This led W. G. Smith to regard him as the prince of fakirs.

1818. T. Holmskiold. Beata Ruris Otia Fungis Danicis impensa. These are most beautiful fine illustrations in colour of Clavariae, Typhulae, Geoglossums, Leotias. I noticed one very curious illustration, t. 13, called *Clavaria aequivoca*, which seemed to me must be an agaric in an early stage, but the illustrious Fries, in his Systema I., 356, refers it to *Polyporus giganteus*. Another *Elaphomyces capitata* on its host, but this gentleman did not observe sufficiently and stuck it tight on to the tuber instead of putting the long slender yellow roots encircling it. We can quite sympathise with him, as we who have dug these things have found how difficult it is to get them out intact. He has also drawn *Cordyceps militaris* on its chrysalis, but I have never seen it in nature as he has depicted it. *Xylaria hypoxylon* fills me with admiration at the carefulness with which it has been drawn and coloured. All the work is beautiful and careful, but this gentleman imagined he saw lots of things.

1822. L. D. Schweinitz. Synopsis fungorum Carolinae superioris, containing two coloured plates. The first is quite pleasing for 1822, except that the white has blackened. Both are of large fungi and microforms.

1824. V. Briganti. De Fungis Neapolitani. Curious black and white drawings quite unique. I have never seen any other illustrations done in this style; they are very good, but suffer as fungus illustrations always do when colour is omitted. This is why photographs (with the exception of coloured ones) are really not much good in the correct determination of Fungi.

1825. A. Brongniart. Essai d'une classification naturelle des Champignons. In this is inserted eight plates. They are black and white and very hard in drawing. Plates 1 and 2 Microfungi, 3 of Myxomycetes, 4 of Scleroderma, 5 of Discomycetes, 6 Agarics, 7 *Phallus* and *Clathrus*, and 8 Pyrenomycetes and Hysteriaceae.

1828. L. de Brondeau. Recuil de plantes cryptogams de l'Agenais. These are drawings in black and white, published in three facicles. There are ten plates. I have not seen them and so did not know in what style they are done, but I am informed that they are "softly" drawn, which means, I expect, that they are not crude and hard.

1823—1829. R. K. Greville. Scottish Cryptogamic Flora. The plates are copper-plate and are very fine diagrammatic drawing, very carefully coloured by hand, and made by

R. K. Greville himself. Spores and microscopic detail are inserted. Some of the larger Fungi are represented, but mostly microscopic Fungi, some of which are beautifully shewn. In some plates he mistook insect work for Fungi, and one Sclerotium looks to me remarkably like an oak spangle. I think the microscopic work must be wonderfully done, when one considers the imperfection of the microscopes at that time. From an artistic point of view I think the work is excellent.

1829. G. Larber, Sui funghi, saggio generale con descrizione dei funghi mangerecci d'Italia. Stiff and wooden plates. It is rather interesting to see the printed plates and then the same plate coloured in the same book, but I think this must only be in the Museum copy, and not usual.

1798—1848. J. Sturm, Deutschlands Flora. The authors responsible for the various fascicles were: Belinair, fascicles 1, 2, 3, 4; J. F. Rostkovius, 5, 16, 17, 18, 21, 22, 24, 27, 28; Corda, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 19, 20; Preuss, 25, 26, 29, 30, 35-36; Schinzlein, 31, 32; Strauss, 33-34. These small sized plates are printed and coloured by hand. They figure all kinds of Fungi, and are all drawn to one scale. The drawing is very delicate and good and the colouring is well done. Spores are not given in some cases, but sections in all, and in some the aperture of the pores. In the Coprini the arrangement of the spores on the basidia and the cystidia on the gills are very well shewn. Many microscopic Fungi are illustrated, and these have been in some cases reproduced in Cook's Handbook of British Fungi.

1831—1849. J. V. Krombholz, Abbildungen der Schwämme, which is in royal folio a truly appalling size. Krombholz, in his seventy-six plates, has given us a fine series of illustrations printed rather coarsely and then coloured by hand, with sections and some spores. The drawing on the whole is much better than the colouring, some of which is very crude and unnatural, but some of the plates are very good. It would seem as though several people had helped in the colouring of the plates, they are so unequal. Plate 6 is a wonderful one, so crowded with all kinds of Fungi, with sections and microscopic details of the moulds, myxomycetes, etc. Geasters, *Phallus*, and *Clathrus* also appear thereon. Plate 8, a fine bold plate of Morchellas and Helvellas, with some asci and spores. Plate 18, a fine life series of *Clathrus cancellatus* and *Phallus impudicus*. Plate 22, a fine plate of *Sparassis crispa*. I wish the colouring was better. Plate 23, Mushrooms poor, but plate 24 is a very fine one of *Lepiota procera* and its relations *L. gracilenta*, *rachodes*, etc., and the colouring is quite subdued and nice. Plate 27, a fine plate of *Amanita Vittadinii* in all stages of development. Plate 31, it seems strange in

this fine series of *Boletus edulis* the lighter edge of the pileus has been wholly overlooked by the colourist, and in the next plate, 32, who would recognise *B. versipellis* with this colouring. The plates of the Boleti are all very crude. Plate 43, the colouring of *Armillaria mellea* is strange, and I do not think many would recognise it. Plate 46, *Merulius lacrymans*, is well shewn. Plates 49, 50, 51, Hydnums, all poor in colouring. Plates 53, 54, Clavariae, all very crude. Plate 59, Truffles with asci and spores well worked out. Plate 60, a nice series of Polysacca. Plates 61, 63, 64, 65, 66, 67, 68, all Russulae; with such a fine series one wishes the colouring was more accurate and not wrong, as they would then have been so useful to enable one to identify this very difficult group. Plates 74, 75, 76, more Boleti, rather rough. On the whole a most interesting set of paintings.

1831—1841. C. Vittadini. Monographia Tuberacearum 1831, Monographia Lycoperdineorum 1841. His plates of Geasters are excellent, the agarics are rather stiffly painted, but in spite of this true to life.

1837—54. A. C. J. Corda. Was one of the artists of Sturm's Deutschlands Flora. In the Icones fungorum hucusque cognitorum the plates, about sixty-four, are black and white, accurate and skilfully represent the Fungi depicted. Many of the drawings are still copied into text books.

1842—1866. The brothers Tulasne, Fungi hypogei 1862 and Selecta fungorum carpologia 1861-66. The former Fungi hypogei consists of twenty-one plates, nine of which are coloured; the uncoloured plates are by C. Tulasne, the painted ones by Lespi. The Selecta fungorum carpologia 1861-65 are black and white drawings by C. Tulasne. Five plates Erysiphaceae, twenty-four plates Xylariae, and twenty-two plates Nectriae, etc. Recherches sur les Nidulariées with most carefully drawn black and white illustrations. So accurate was their work that many of the species that the brothers depicted and described in their books as probably representing life stages in the development of one fungus have since been proved by cultural experiments to be included in the life cycle of one species. The drawings in all cases are most excellent, and I would more especially comment upon the diagrams of the moulds, which are magnificent.

1842. Joseph Roques, Champignon comestible et venineuse. Large plates of fungi well drawn and sometimes well coloured. On the whole very pleasing and easily recognised. Some of the plates are really very fine, especially the Amanitas.

1842—45. C. F. Harzer, Abbildungen der Pilze contains eighty plates. In some copies in black and white, in some coloured. These drawings are very hard, and when coloured

in many cases quite unnatural, and often made worse by making them "shiny" like cheap German coloured printing of the pre-vellum days.

1842—45. J. Venturi, Studi Micologici 1842, with eleven plates and one hundred and twenty-five drawings, almost entirely of Basidomycetes, and shewing sections. Miceti del Agro Bresciano 1845, with sixty-four plates of Agarics, except one of Morels. Some of these drawings are excellent, but many impressionist and black-chalky.

1844. J. F. Rostkovius. Rotkovius' drawings are in Sturm's Deutschland's Flora. The drawings in the Pilze are done by different people; usually the author of the fascicle did the drawings. The drawings are generally very excellent.

1847—55. Mrs. Hussy, Illustrations of British Mycology. These plates are beautifully and artistically painted and very well reproduced, and the colour is good. Unfortunately there are no sections or scientific detail inserted.

1851. H. F. Bonorden, Handbuch allgemeine Mycologie. With twelve coloured plates, principally of microscopic Fungi, but certain larger Fungi such as Nyctalis, Naematelia, Calocera, Hypochnus, Thelephora. The microscopic details are very well shewn with spores and basidia.

1859—1892. J. B. Barla, Les Champignons de Nice 1859, Suite aux Champignons de Nice 1886, Champignons des Alpes maritimes 1888-92. These coloured illustrations are very good and very bold work, in which sections are inserted. He certainly gets the characters of the Fungi he has painted.

1860. Rev. Miles Joseph Berkeley, M.A., F.L.S. Outlines of British Fungology. This work is illustrated by twenty-four plates, on which are crowded many species of Fungi. Some of the larger agarics are much reduced. They are plainly drawn diagrams, simply coloured, and with no pretension to high artistic merit. They serve well as useful illustrations by which to distinguish the ordinary run of Fungi.

1864-1865. Sarah Price, Illustration of the Fungi of our Fields and Woods. Some of these coloured illustrations are beautiful, but in many the colours are not true to nature, probably the result of reproduction. There are no sections inserted or scientific detail, in fact a great lack of detail in all the plates. *Coprinus atramentarius* is very life-like, also *Bulgaria inquinans*, and she has caught well the characters of both of these Fungi.

1867—1885. Elias Fries. The great master of Fungi in his Icones Hymenomycetum has in his first volume one hundred large plates, including ten of Hydnums. They were executed for him, under his direction, by various people, namely, Messrs. Lindgren, E. Pettersson, P. Akerlund, H. von

Post, O. Gottman, E. P. Fries, A. G. Hafström, and A. F. Carlson. These are a beautiful series of scientific paintings, with sections but no spores. In many cases the drawing is curious, but it is accounted for in the delineator's eagerness to show the gills and the underside of the specimens. The colouring of the tops of the pilei is very flat and the edges of the same are very regular, hardly ever showing a break, mechanical, and are thereby unlike nature. Perhaps it may be correct scientifically, but it offends terribly our artistic sense. When the artists do insert a crack it seems a terrible effort to them. But, in spite of all this, the shapes of the Fungi are beautifully and characteristically drawn, and we all know what the process of reproduction does for one's own cherished paintings. *Collybia platyphylla* var. *repens* would, I am sure, please Professor Buller, it shows so well the cord-like mycelium of these Fungi. The second volume, also of one hundred plates, with the portrait of dear old Elias Fries himself, and his signature. The face is beautiful and so intelligent and lovable, and there is a tremendous vitality in the expression of it. I feel I should dearly have liked to have known him. The second volume is, I think, better executed than the first, the texture of the surfaces of the Fungi being better given. The first two plates are very fine ones, being those of *Pholiota aurea* and *spectabilis*, two fine subjects for the artist's brushes. I daresay the old master curbed the artistic tendencies of his delineators in his eagerness to emphasise the scientific details of the specimens and make clear to our minds exactly the special points of the fungus, and if we lose a little artistically, who can blame him. The colouring is both true and beautiful. My husband informs me that it is almost impossible to reconcile his descriptions of the Cortinarii with the published plates in his Icones.

1869. W. Gonnermann and L. Rabenhorst, Mycologia Europaea. These figures are drawn from nature by W. Gonnermann. These are beautiful plates with sections, magnified spores and portions of structure of the plants. One can now see the advantage the improved microscopes have given the workers. Tab. 3 is a beautiful illustration of *Amanita caesarea*. These are model plates in giving the fungus in all stages excepting the old ones. The fault I have to find with them is that they are too clean and perfect. Tab. 12, the anatomy of *Amanita muscaria*, is beautifully drawn and the mushrooms are well depicted and grouped together in the second series, Agaricus, Tab. 1 and 2. Tab. 3, a very good (stiff) one of *Armillaria mellea*, shewing the characters well, but not its wonderful variety. Tab. 7, a full page of Mycenas, beautifully drawn but with few spores. Tab. 8, Marasmius well shewn. Tab. 10, 11, Hygrophorus all

well delineated. The third series, the Boleti, are well drawn, and Tab. 7, showing pores and spores, are beautifully clear. The fourth series, Pezizae, are well worked out, but the colouring is very flat and uninteresting. The fifth series, the Pyrenomycetes, are black and white drawings with a slight wash of colour put in very occasionally. The drawing is very clear and diagrammatic. My husband informs me that although I may admire the delineation of the drawings he has not much respect for the accuracy of the names attached to the plates.

1872. W. W. Saunders and W. G. Smith, Mycological Illustrations in two parts, with forty-eight plates. These drawings are coloured. Smith's are in his usual style and are quite as good, though rather better printed than usual. Saunders' are made much better, I imagine by Smith's lithography. Sections and spores, etc., are inserted. The majority of the originals are at the British Museum.

1872—1884. L. Quélet, Les Champignons du Jura et des Vosges. I have a few plates before me, from the Memoires de la Société d'Emulation de Montbéliard. They are printed and then coloured by hand. The drawing in some cases is rather fine, but the colouring is not very good. From an artistic point of view these plates are not of much account. Some sections are given but not many spores. Asci are given and spores in the plates of Pezizae, Tubers, etc. Quélet was very shifty over the citation of his own plates, and often changed their names. Indeed he does this often in quoting other published illustrations. Sometimes rightly, sometimes erroneously. At times Quélet is a great splitter of species, at other times he is a great lumper, and has plunged most fearfully in this respect in many instances. Take *Pholiota aurea* and *spectabilis* one species only. We know these are two very distinct species. Again, *Thelephora intybacea* cannot possibly include such distinct species as *Thelephora Sowerbeyi*, *Stereum multizonatum*, and *Thelephora intybacea* itself. Quélet did good work, and his descriptions of the Agarics set out in his Flore mycologique de la France are of the greatest assistance to all mycologists at the present time.

1878—1890. C. Gillet, Les champignons de la France, Hyménomycètes, Discomycètes, Gastéromycètes. These contain eight hundred and eighty-six coloured plates, and the illustrations are plain useful work, but from an artistic point of view not of much moment.

1881—1890. M. C. Cooke's monumental work, Illustrations of British Fungi, is by far the best series of paintings that have yet been published in Europe dealing exclusively with the Agaricaceae. Some of the plates are excellent, but

their value would have been very greatly enhanced had a section always accompanied the painting, and the spores, seldom included, drawn to a magnification enabling one to attribute some value to their distinctive features. Some of the plates exactly represent our Agarics as we see them in the fields and woods, but others only suggest the same after they have undergone great changes from drying. Perhaps his series of Cortinarii are the best in colour and more truly represent out native plants. Some plates, on the other hand, must be based on a wrong identification of the plant and so are slightly misleading, as for example his illustration of *Lepiota Bucknalli*. The drawing and painting of the plates are very beautiful and the reproduction good. It is a grand work, and we must all testify to the grit and perseverance of the man who published it.

1881—1896. Jacob Bresadola, Fungi Tridentini, also Funghi mangereccie velenosi (1899). These are a series of very carefully drawn plates, printed in colours, with sections, magnified spores, basidia, asci, paraphyses, and details of structure of many kinds of Fungi from original paintings by Bresadola himself. Mechanical but very useful and accurate work, the colouring subdued and not elaborate. These plates are accompanied by very accurate descriptions, which are of the greatest use to the systematist. Bresadola was the first to give a clear diagnosis of the characters that separate *Russula delica* from *Russula chloroides (Lactarius exsuccus)*. He elucidated the differences between many other critical species and created many new species that have since been met with in Britain.

1884—86. L. Lucand, Iconographie des Champignons. These are flat, crude, coloured illustrations with sections and spores.

1885. Karsten, P. A., Icones selectae Hymenomycetum Fenniae. There are eighty species drawn and the plates are almost exactly the same as Fries' Icones.

1891. M. Britzelmayr, Hymenomyceten aus Südbayern. The illustrations are just too dreadful for words. The drawing and the colouring is crude in the extreme; sections and spores are given. His work is quite useless.

1904. Ladislaus Hollos, Gasteromycetes Hungariae ("Die Gasteromyceten Ungarns.") There are thirty-one beautiful plates of Gasteromycetes in a large size, with sections and spores and other scientific details. They are beautifully painted and drawn and the reproduction is very fine, being by colour photography. His lumping together of species however is simply preposterous, and shows to what false deductions authors are led who rely on microscopic characters only.

1904—1910. Emile Boudier, Icones. These I consider the most artistic and thoroughly scientific illustrations that have been published. They are simply magnificent, and I speak more feelingly of them because their author is our friend, and the reproductions though good are not a tithe of the originals. We regret that so few illustrations aid us with our beloved Basidiomycetes, but Monsieur Boudier's special group were the Discomycetes, and I feel sure we shall soon make British all his species. So excellent and accurate are the drawings and microscopic details that no difficulty can arise in the identification of any specimen. All mycologists owe a great debt to Monsieur Boudier for his clear definition of species and his accurate illustrations thereof. I feel inclined to join those mycologists who say " Without a good illustration of a species, no recognition thereof."

1906—7. L. Roland. Atlas des Champignons. These are a series of small illustrations drawn for Monsieur Roland by A. Bessin. These one hundred and twenty plates are rather flat and mechanical, and include specimens of Agarics, Boleti, Polypores, Pezizas, and a few other species of Fungi. They were issued as a supplement to the Bulletin de la Sociéte Mycologique de France. The drawing is good, but diagrammatic and the colouring is very flat. Plate 17 is typical, and on plate 31 *Lactarius torminosus* is really very good; so is *L. blennius* on plate 32, and *L. deliciosus* and *L. sanguifluus* on plate 34. But there are a good many very poor representations of the Fungi illustrated. Paul Klincksieck's printing was generally much better than this, so I think the plates themselves must have been poor. There are sections inserted but no spores.

1887—1915. George Massee. British Fungus Flora, vols. I.-IV.; Revision of the Genus *Coprinus;* Monograph of the Geoglosseae; Revision of the Genus *Cordyceps;* Monograph of the genus *Calostoma;* Monograph of British Gastromycetes; Monograph of the genus *Inocybe;* &c. That Mr. Massee is a competent draughtsman and artist I think we all admit, though his work is rather hard and mechanical. He has been a voluminous writer and has done very unequal work, and it is to be regretted that it was not more thorough.

Worthington G. Smith. His illustrations as I know them on the swing boards at the British Museum (Natural History) are well drawn, but very highly coloured. They are a fine series, but lack in most cases sections and magnified spore delineations. They suggest to my mind a compilation, and not what we see in the field. His colour descriptions in the Catalogue to my mind beggar description. It seems a pity that Mr. Worthington Smith, when he had drawings to work from

drawn from the actual specimen, did not accurately copy them, and in his Notes for the British Museum was content to make just a bare tracing of the painting.

1909. W. Swanton. Fungi and how to know them. This book is illustrated by Miss M. K. Spittal with forty-eight plates. The drawing, colouring and reproduction are good: and the whole work was just what was wanted to stimulate beginners in fungus study.

1914. Jacob E. Lange. Studies in the Agarics of Denmark. Part I. The Genus *Mycena*. This is a small monograph on the Mycenas with one daintily coloured plate and another showing in outline the spores, basidia, cystidia, and surface cells. Amongst the letterpress there is also a small illustration of types of Mycena-spores, arrangement of spores on surface of gill and types of cystidia. A most excellent monograph.

C. G. Lloyd has during the past decade or more issued his Mycological Notes and various monographs dealing chiefly with the Gasteromycetes and Polyporaceae. These are illustrated by some magnificent photographs, but although their excellence is great, one feels it is quite impossible to identify what is represented, owing to the lack of colour, which is so necessary to give the right appreciation of many genera and species. Up to the present I am not acquainted with any colour photographic reproductions of Fungi taken from the living Fungi themselves, but only those reproducing coloured paintings such as accompany Hollos's Gasteromyceten Ungarns and those of Paul Kliensieck's postcards, all of which appeared in his edition of Dumée's Atlas des Champignons. On Friday night my friend, Mr. A. D. Cotton, will pass a series of coloured slides through the lantern. These are by our member Lt.-Col. Theodore Green, who some years ago placed his slides before us at the Baslow meeting, and we all agreed that they were the best that we had yet seen on this subject, though they left much to be desired. This is due in a great measure to the fact that in many instances the majority of the colours are opaque, and that for instance in the yellow colours they have only one transparent colour to work with. Their illustration by coloured lantern slides I feel would greatly stimulate an interest in the study of Fungi. I have seen no lantern slides of Fungi from the positive plates that are obtained by means of the starch grain process, but I have seen some very life-like representations of butterflies taken by this process. However all photographic plates and lantern slides lack sections and microscopic details, which are so essential to a right appreciation of a species.

This concludes the enumeration of the various illustrators of

Fungi, which I have passed in brief review from the earliest times to the present day, shewing the great advances which have been made from time to time in the studies of Fungi.

NEW BRITISH FUNGI.

By John W. Ellis, M.B., F.E.S.

Diaporthe longirostris (Tul.) Sacc. *Valsa longirostris* Tul. Sel. Fung. Carp. II., 200. Sacc. Sylloge I., 609.

Stroma scanty, situated in the outer layer of the bark; perithecia oval, arranged in groups of three to eight or more in an irregular circle, with long (·5-·75 mm.), slender, straight or slightly curved necks, which taper slightly towards the extremity and which project above the surface of the bark in clusters; contents of perithecium dark grey; asci elongate-elliptical with a short stalk, 30-40μ × 8-12μ; spores crowded, bi-seriate, linear-oblong, slightly curved, obtuse or sub-acute at both ends, at first simple with four vacuoles, then uniseptate and slightly constricted at the septum, 17-20μ × 3·5μ, hyaline.

On dead bark of *Acer Pseudo-platanus*, Hassop, Derbyshire, May 25, 1915.

But for the uniseptate spores this species might easily be mistaken for *Valsa ceratophora* Tul. The determination of this species was kindly confirmed by the eminent Italian mycologist, Professor P. A. Saccardo.

Phoma striæformis Dur. et Mont. Alg. p. 603. Syll. n. 977. Sacc. Syll. III., p. 131 (No. 785).

Perithecia more or less elongate oval, at first covered by the epidermis, then opening by a long slit (in a hysteriiform manner). The perithecia which are arranged between the longitudinal fibres of the stem tend to unite longitudinally so as to produce distinct dark lines. Spores elliptical, rounded at both ends, and containing two prominent guttulæ, 6-8μ × 2·5-3μ, hyaline.

On dead stems of *Chærophyllum temulum* (especially on the swollen joints), Storeton, Cheshire, February, 1915.

The rows of perithecia bear a strong resemblance to the sori of the teleutospore stage of *Puccinia graminis*.

Phoma coneglanensis Sacc. Mich. II., p. 340. Sylloge III., p. 81.

Perithecia oblong or oblong-oval, $\frac{1}{3}$ to $\frac{2}{3}$ mm. long, covered by the epidermis, which is blackened and ultimately pierced

by a small round pore; spores oblong-fusoid, hyaline, with two guttulæ, 7-8 × 2·5-3μ, on sporophores of about twice the length of the spores.

On fallen petioles of *Æsculus hippocastanum*, accompanied by a *Diaporthe* (?) without spores. Hooton, Cheshire, May 1, 1915. Recorded by Saccardo from France and Italy.

Cytospora pruinosa Sacc. Mich. I., p. 519, var. *Lantanæ* Sacc. (loc. cit.).

Stroma grey, multilocular, causing a distinct roundish swelling beneath the epidermis, which finally bears at the most prominent portion a grey disk which is pierced by a black ostiole; spores allantoid, 5-7μ × 1μ, hyaline, on branched sporophores.

On dead twigs of *Viburnum Opulus*, Raby Mere, Cheshire, Jan. 23, 1915.

This plant was transferred to *Dendrophoma pruinosa* in Saccardo's Sylloge III., 179, and placed by him in that genus, probably on account of its branched sporophores. This latter character, however, is one possessed by other species of the genus *Cytospora*, *e.g.*, *C. Abietis*, besides which the species in question undoubtedly has a multilocular stroma. The type form of *C. pruinosa* has been recorded from Twycross, on Ash.

Cytospora Sarothamni Sacc. Sylloge III., p. 272 (No. 1582).

Stroma multicellular, situated beneath the epidermis, which becomes elevated and convex and terminates in a grey disc from which the ostiole ultimately protrudes as a black papilla. Spores cylindrical, straight or slightly curved, 7-9μ × 1·5μ, hyaline, on caespitose sporophores, which are 12-15μ long.

On dead branches of *Cytisus scoparius*, near West Kirby, Cheshire, April, 1915. Hitherto recorded only from Germany.

ASCOCHYTA OLERACEA n.s.

Peritheciis gregariis, in maculis pallidis, $\frac{1}{6}$ mill. diam., globosis, luteo-fuscis, poro pertuso apertis; sporis cylindricis utrinque rotundatis, uni-septatis, 10-12μ × 3μ, hyalinis.

In caulis emortuis *Brassicæ campestris*, Hadlow Road, Cheshire, June 21, 1913.

Certainly distinct from *Ascochyta Brassicæ* Thüm., which has much larger and acutely pointed spores.

Hendersonia Epilobii Fautrey in Rev. Mycol. (1889) 152; Sacc. Syll. X., 825.

Perithecia elongate-ovate, arranged somewhat in rows, covered by the epidermis, black, opening by a minute pore;

spores elongate oval, 3-septate, 15μ × 6-7μ, yellow, with the basal joint paler; sporophores 20μ × 1μ, hyaline.

On dead stems of *Epilobium hirsutum* at Meols, Cheshire, March, 1915.

Myxosporium incarnatum (Desm.) Bonord. Handb., p. 56; Sacc. Mich. I., p. 116, F. it. t. 1073; Syll. Fung. III., p. 722 (No. 3769).

Pustules more or less convex, sub-epidermal, somewhat paler than the surrounding bark; spores obovoid or sub-pyriform, hyaline or slightly flesh coloured, distinctly granular, 15-20μ × 8-10μ, on sporophores 20-24μ × 2μ.

On dead twigs of Laburnum, Eastham, Cheshire, May, 1915.

Probably this is *M. Roumegueri* Sacc. Mich. II., p. 354, Syll. *loc. cit.*, which seems to differ from *M. incarnatum* only in its slightly larger (25-27μ × 8-10μ) spores, which are less pyriform in outline, a difference which scarcely justifies more than varietal rank, and it is only treated as a sub-species in Rabenh. Cryp. Fl. 7, p. 521. My specimens appear to be somewhat intermediate between type and variety. The type has occurred on various trees in the mid-European area; *M. Roumegueri* only on Laburnum in the South of France.

Myxosporium Lanceola Sacc. et Roum. Reliq. Myc. Lib. Ser. IV., No. 168, f. 48; Sylloge III., p. 726 (No. 3797).

Pustules pallid, surrounded by a dark line, subcutaneous, causing the epidermis to project as small, convex, smooth, swellings which are paler than the surrounding cortex; finally the epidermis becomes ruptured and the spores are extended as a flesh-coloured tubercle (or when dry as a whitish powder); spores oblong-fusiform, straight or slightly curved, with the ends sub-acute or slightly obtuse, 14-22μ × 3-4μ, hyaline.

On terminal twigs of oak, Capenhurst, Cheshire, May, 1915.

Previously recorded by Libert from the Ardennes.

Septomyxa Æsculi Sacc. (*Myxosporium ? aberrans* Sacc. Mich. I., 128) Sylloge III., 766, No. 4022.

Pustules gregarious, pale ochreous within, situated beneath the epidermis, which is slightly raised and paler than the surrounding bark, then erumpent as a flesh-coloured or pinkish tubercle; spores oblong-fusiform, slightly obtuse at both ends, uniseptate, 12-16μ × 2·5-3μ, hyaline.

On twigs of *Æsculus hippocastanum*, Hooton, Cheshire, May, 1915.

Previously recorded only from Germany.

SEPTOMYXA FAGICOLA n.s.

Acervulis subconvexis, nigris, primo epidermide velatis dein erumpentibus in globulis nigris; sporis oblongo-fusiformibus, untrinque obtusis, rectis vel leniter curvatis, 4-guttulatis, uniseptatis, 12-24μ x 2-3μ, hyalinis.

In ramulis *Fagi sylvatici*, Hassop, Derbyshire, May 24, 1915.

The spores are indistinctly septate until treated with iodine, when the vacuoles disappear and the septum becomes prominently visible.

NEW OR RARE MICROFUNGI.

By A. Lorrain Smith, F.L.S., and J. Ramsbottom, M.A.

We are again indebted to Mr. D. A. Boyd for forwarding to us the interesting species of microfungi which he has gathered, and which include many new records for the country and many species new to science. In the present paper we have taken the opportunity to gather together many stray records of Phycomycetes, and have also included the species of Plasmodiophoraceae made known by the work of Dr. E. J. Schwartz.

PLASMODIOPHORACEAE.

SOROSPHAERA Schroet. Kryptfl. Schles. III., 1, p. 135 (1886).

Occupying the interior of the host cells. Spores ellipsoid-cuneate, several united into hollow balls, surrounded by a common membrane.

S. Veronicae Schroet. l.c.

Spores cinnamon-brown: spore balls (sorospheres) globose or ellipsoid, 18-28μ x 18-23μ, several in one host cell formed of numerous ovate spores, wedge-shaped, with narrow part inwards, 8-9μ x 4-4·5μ, with a smooth clear-brown membrane thickened over the apex. Forming cylindrical, often curved tubercles about 3 mm. thick in stems and petioles of *Veronica Chamaedrys*.

Sevenoaks, Kent (Blomfield and Schwartz in Ann. Bot. XXIV., p. 35 (1910)).

LIGNIERA Maire and Tison in Compt. Rend. CLII., p. 206 (1911).

Parasitic in the unchanged cells of the host not forming tumours: spores united in variously shaped masses.

L. Junci (Schwartz) Maire & Tison l.c.

Spores smooth, wedge-shaped, 5-7μ, loosely aggregated or united into spherical or ellipsoid hollow balls.

In the root cells of *Juncus* spp. Sevenoaks, Kent. *(Sorosphaera Junci* Schwartz in Ann. Bott. XXIV., p. 236 (1910).*)*

L. graminis (Schwartz).

Spores smooth, subglobose, varying considerably in size with an average diameter of about 6μ, the hollow spore balls rarely spherical, usually oblong with slightly rounded ends.

In the roots of *Poa annua*, Sevenoaks, Kent. *(Sorosphaera graminis* Schwartz in Ann. Bot. XXV., p. 791 (1911).*)*

Maire and Tison (l.c.) described a parasite on *Poa annua* as a *Ligniera* akin to *L. Junci.* Schwartz (Ann. Bot. XXVIII., p. 231 (1914)) apparently accepts the generic transference.

L. Bellidis Schwartz in Ann. Bot. XXVIII., p. 232 (1914).

Amoebae rare in the cells of the host. Spores 5-6$\mu \times$ 4-5μ, united in variously formed balls, usually ellipsoid.

In roots of Compositae. Sevenoaks.

" Closely related to *L. graminis* and *L. Junci*, but appears to be distinct, since grass and rush-roots in the immediate vicinity of diseased daisies were found free from infection."

L. Menthae Schwartz l.c.

Amoebae in the root cells of the host. Spores 3-5$\mu \times$ 4-5μ, in globose or variously formed groups.

In roots of *Mentha Pulegium.* Chiselhurst.

L. Alismatis Schwartz in Tom. cit. p. 233.

Amoebae rare in the cells of the host. Spores 3$\mu \times$ 4μ, the groups arranged similarly to those of *Spongospora*, or in rows or in spheres.

In roots of *Alisma Plantago.* Dunton Green, Kent.

PHYCOMYCETES.

Olpidium Gillii Wildeman, in Ann. Soc. Belge. Micros. XX., p. 42 (1896).

Zoosporangia elliptical, solitary or in groups of two or three in a diatom; neck of zoosporangium always single, piercing the valves and often of considerable length, sometimes reaching half the length of the diatom itself; zoosporangium membrane smooth. Zoospores numerous. Zoosporangia variable in size according to the diatom attacked and the number of parasites contained in a cell.

In *Pleurosigma attenuatum*, *Cocconema lanceolatum*, *Nitzschia* sp. New River, London.

This fungus was figured and described by C. H. Gill in Journ. Micros. Soc. I., p. 1 (1893) as *Ectrogella bacillariacearum* Zopf. Wildeman points out that Gill's figures 1-8 are of an *Olpidium*, and only figure 9 is *Ectrogella*.

O. tumaefaciens (Magnus) Berl. et De Toni ex Sacc. Syll. Fung. VII., p. 312 (1888).

Sporangia single or massed to the number of eight, globose or ellipsoid, with colourless smooth membrane, with long projecting beak, sometimes two beaks on one sporangium; zoospores globose, uniciliate; resting spores unknown.

Chiefly in the rhizoids of *Ceramium flabelligerum*, and *C. acanthonotum* in the end cell, and also in the middle and basal cells of the hairs, seldom in other parts of the plant; causing swelling of the affected host cells.

Recorded from near Edinburgh by Magnus. (Sitzungsb. d. naturf. Freunde Berlin 1872.)

The following two species are included in our British Flora on the authority of E. A. L. Batters in Grevillea XXI., p. 103 (1893), where he states in a review of G. Murray's paper *Parasites on Algae*:—"On our own coasts *Chytridium tumefaciens* is commonly to be met with on species of Ceramium, *Ch. sphacelarum* on Sphacelariae and Cladostephi, and *Ch. plumulae* on *Antithamnia*."

O. sphacelarum (King) Fischr. in Rabenh. Krypt. Fl. I., 4, p. 26 (1892).

Sporangia single or massed to the number of nine, globose or angular through pressure, with smooth, colourless membrane, with projecting beak; zoospores elongate, uniciliate; resting spores unknown.

In the large apical cell of Sphacelariaceae, causing it to swell and become brown or blackish.

O. Plumulae (Cohn) Fisch. in Rabenh. Krypt. Fl. I., 4, p. 27 (1892).

Sporangia located between the wall and the contents of the host cells, single, subglobose or ovoid, reddish or brownish-red, about 15μ in diameter, beak not projecting; zoospores and resting spores not described.

In *Antithamnion Plumula*, causing swelling of the basal cells of the branches.

ECTROGELLA Zopf. in Nova Acta Acad. Leop. XLVII., p. 175 (1884).

Vegetative body long, unbranched, vermiform probably from the first provided with a membrane, the whole of it becoming a sporangium. Sporangia usually extended and vermiform with very thin colourless membrane with many short beaks. Zoospores small, feebly amoeboid, uniciliate. Resting spore and sexuality unknown.

E. bacillariacearum Zopf. l.c.

Sporangia either single, vermiform, 200μ or more long (often filling the whole length of the host cell) or short, spindle-shaped or ellipsoid, as many as thirty in a cell; mostly arranged in the long axis of the host, with one, or two rows of short papilla-like beaks which are always directed towards the girdle of the diatom host and empty on the falling apart of the valves: the diatom wall is not penetrated. Zoospores very small, spherical, 2-3μ in diameter, weakly amoeboid, uniciliate, with diminutive oil-drops.

In *Nitzschia sigmoidea*, New River, London. C. H. Gill in Journ. Roy. Micros. Soc. I., p. 1 (1893).

PLEOLPIDIUM Fischr. in Rabenh. Krypt. Fl. I. iv., p. 43 (1892).

Fruit bodies endogenous, surrounded at first by a very delicate membrane and not clearly to be distinguished from the contents of the host cell. Sporangia clavate or barrel-shaped, single, terminal or intercalary, filling the whole breadth of the host cell and their walls closely adpressed to the wall of the host excepting in the transverse direction; beaks short. Zoospores reniform, spherical or ellipsoid, uniciliate, with irregular movement. Resting spores in spherical or club-shaped intercalary or terminal swellings of the host filament but not cut off by transverse septa; round, with large central oil drop and membrane with fine prickles. No sexuality yet known.

P. irregulare Butler, in Memoirs Depart. Agric. Ind. I., p. 123 (1907).

Sporangia formed in the hyphae of the host, irregular in shape, terminal and intercalary, averaging 23μ in diameter, with a single papilla; zoospores obclavate, with a single cilium borne posteriorly; durable spores single, free in the cavity of the host-filament, which is enlarged to contain them, numerous, 11-15μ in diameter, spherical, of a pale yellow colour, with a moderately thick wall, provided with short regular spines; germination not observed.

Parasitic in *Pythium ? vexans*, Kew, 1900, from soil containing roots of *Ophioglossum vulgatum*.

P. cuculus Butler l.c.

Sporangia spherical or pyriform, formed in the spores of the host from which they cannot be distinguished, terminal, regular, about 20μ in diameter, with a single papilla; zoospores as in *Pleolpidium irregulare;* durable spores rare, spherical, single, free in the cavity of the spore of the host, 12-17μ in diameter, (?) smooth, pale yellow; germination not observed.

Parasitic in *Pythium intermedium*, Cork.

WORONINA Cornu in Ann. Sci. Nat. ser. 5, XV., p. 114 (1872).

Sorus endogenous with scarcely recognisable membrane, consisting of a mass of zoosporangia free in the host cell and more or less filling it, without a common membrane. Single sporangium, globose or flattened by contact; zoospores biciliate issuing from a wart-like papilla which pierces the wall of the host plant. Resting stage a globose sorus of closely packed sporangia, which on germination swell up and produce zoospores.

W. polycystis Cornu Tom. cit. p. 176.

Sporangial sori in rows, about 104μ × 30μ, each sorus bounded by a wall; the sporangia loosely aggregated, almost globose up to 14μ in diam., with a papillate opening. Zoospores ovoid, biciliate, about 4μ × 2μ. Cystosori single or in rows, in swollen cells of the host, globose or irregular, greyish brown, 40-104μ in diam., the outer membrane brown, with conical warts. Single sporangia angular through pressure, 4-5μ in diam., with a strongly thickened membrane.

In *Saprolegnia* hyphae. Not uncommon.

RHIZOPHIDIUM Schenk, Über das Vorkommen kontraktiler Zellen, 1858.

Vegetative body consisting of a usually spherical portion which is epiphytic and a branched or unbranched filamentous endophytic portion; the whole is surrounded by a membrane and is unicellular. The spherical portion enlarges and gives rise to a sporangium or a resting spore, after which the filamentous portion collapses. Zoosporangia sessile, spherical, elongate-clavate, or of some particular shape, with colourless, smooth, fairly thin membrane, emptying through one or more, sometimes slightly projecting, openings. Zoospores passing out in succession, uniciliate, spherical with refractive oil drops; movement darting. Resting spores sessile, spherical, with

colourless or slightly brownish, usually smooth, thick membrane, and a large central oil drop.

R. Eudorinae Hood in Proc. Birmingham Nat. Hist. and Phil. Soc. XII., p. 45 (1910).

Mycelium represented by a thin unbranched protoplasmic thread. Zoogonidangia resting upon the host-cell, flask-shaped, with a rather long neck and a colourless smooth wall, opening by an aperture produced by breaking down of the wall at the apex. Zoogonidia numerous, of ovoidal form, with a single cilium and a minute refractive oil drop. Resting-spores spherical, formed asexually and external to the host-cell, with a thick, colourless, and somewhat sparsely granulated wall, and containing a large oil drop. Length of zoogonidangia 20-35μ; breadth of zoogonidangia 10-17μ; diam. of zoogonidia 2μ; diam. of resting-spores 10-16μ.

A parasite on the motile colonies of *Eudorina elegans*. Abundant in Bracebridge Pool, Sutton Park, Warwickshire (1908-9).

"The attack was most evident in the early autumn when the *Eudorina*-colonies were becoming very numerous, and material collected in October, 1909, showed all the early stages of attack. The temperature of the water at the time was 12° C. During the winter of 1908-9 the infection was extremely severe, whereas in the following winter it was comparatively slight, the *Eudorina* collected in February, 1910, having apparently completely recovered from the attack."

R. Dicksonii Wright in Trans. Roy. Irish Acad. XXVI., p. 369 (1877).

Unicellular; at first quite globular in shape; but during growth becoming very irregular in form, often assuming quite an oblong shape; living in the cells of *Ectocarpus granulosus*, and frequently distorting its filaments. The numerous zoospores make their escape through one or two apertures.

Parasitic in the cells of *Ectocarpus granulosus*, and occurring in great numbers; gathered at Howth, near Dublin, during the winters of 1876, 1877.

R. Barkerianum (Archer) Fischer in Rabenh. Krypt. Fl. I. iv., p. 103 (1892). *Chytridium Barkerianum* Archer in Quart. Journ. Micros. Sci. VII., p. 89 (1867).

Cells much depressed, three- or four-lobed, the lobes broadly rounded; upper surface of the cell concave, bearing at the centre a vertical, hyaline, very slender, terete, minutely capitate process; the cell contents mainly confined to the centre,

leaving the ends of the lobes empty; zoospores making their exit through the opened apices of the lobes.

On *Zygnema*, Callery Bog.

The zoospores make their exit from the opened ends of the radiating lobes. The cell-contents of the joint of the *Zygnema*, on which the fungi were established, were always effete and brown coloured, and destroyed. Occasionally the attachment and root-like appendages of the fungus could be seen penetrating into the *Zygnema*-cell, but more frequently, on a lateral view, the parasite seemed to be seated, merely superficially thereon, and without any apparent means of attachment.

Pythium monospermum Pringsh.

Saprophytic in soil, Cork. E. J. Butler in Memoirs Dept. Agric. India I., p. 71 (1907).

P. vexans de Bary.

Saprophytic in garden soil, Cork; Kew. E. J. Butler in Tom. cit. p. 93.

P. intermedium de Bary.

Saprophytic in garden soil, Cork; Kew. E. J. Butler in Tom. cit. p. 97.

Saprolegnia torulosa de Bary.

On dead fish in pond of Botanical Garden of Bristol University, Jan. 1910.

A. E. Lechmere in New Phyt. IX. p. 305 (1910) and X. p. 201 (1911).

DISCOMYCETES.

Taphrina Carpini Rostr. in Bot. Tidskr., XIV., p. 238 (1883).

Forming "witches' brooms" on *Carpinus Betulus*, causing the leaves to turn deep yellow. Asci formed on the under side of the leaves between the veins, 25μ × 8-12μ, cylindrical above with a broad base, 20-24μ wide; spores about 4μ in diam.

May to August. Not uncommon in Epping Forest.

OTIDEA VIOLACEA n. sp.

Ascomata substipitata, uno latere elongata, extus furfuracea, extus intusque violacea, ad 6 cm. lata; ascis cylindraceis, c. 300μ × 10μ, apicibus iodo caerulescentibus; paraphysibus linearibus, vel tenuiter clavulatis; sporis ellipsoideis, hyalinis, 10μ × 5μ, biguttulatis.

In solo hortense.

Coll. W. B. Grove, Warwick, 1915.

There is a coloured drawing by Mrs. Russell in the Collection of the National Herbarium, of this fungus collected at Wick, Somerset, August, 1855. Differs from *O. leporina* in the violet colour, the spores and the straight paraphyses.

LASIOBOLUS OLIGOTRICHUS n. sp.

Ascomatis gregariis, sessilibus, conicis, levibus, aurantiacis, primum clausis dein irregulariter apertis, externe cellulis irregularibus compositis, 100-210μ cr. × 280-300μ longis, extus pilis pleurumque perpaucis obsitis, simplicibus, non septatis, rectis, acutis, hyalinis, c. 85-95μ × 5μ; ascis paucis subcylindraceis sursum rotundatis, fere sessilibus, 90-140μ × 18-30μ iodo non caerulescentibus; paraphysibus gracillimis, numerosis, ad 150μ × 2·5μ, vacuolatis, hyalinis, rarissime septatis vel ramosis, ad apices non dilatatis; sporis ellipsoideis, c. 20μ × 12μ.

In stercore Cuniculorum.

Coll. on foray of Essex Field Club, Epping Forest, Oct., 1915.

Somewhat similar to *Lasiobolus equinus*, but differing in the shape and size of most of its parts and especially in the colourless, generally unbranched paraphyses. The asci vary in number from two in the smaller forms up to about ten. The hairs may be entirely absent or vary in number from one to several.

The fungus can be grown on agar-agar made up with a decoction of rabbit dung, to which filter paper has been added. The amount of hairiness then appears to depend upon the amount of moisture.

Cenangella Ericae (Niessl.) Rehm. in Rabh. Krypt. Fl. I. 3, p. 232 (1889).

Apothecia solitary, at first closed, spherical, narrowed to a short stalk, then sessile, opening and exposing the greyish-white disc, externally brown, when dry, closed, wrinkled and almost black, very minute, ·5-1 mm. wide; asci clavate, 70-90 × 8-10μ; spores fusiform, straight, two-celled, mostly biguttulate, with a broad central septum, 15-18μ × 3-4μ; paraphyses filiform often forked, septate widening upwards.

On dead leaves of *Calluna vulgaris*. Coll. D. A. Boyd, Beith, Ayrshire, May, 1912.

The specimen from Ayrshire differs in some slight respects from Rehm's description. The apothecia and asci are somewhat smaller and the paraphyses appear to be filiform throughout.

Pyrenopeziza maculans (Rehm) Boud.

On dead leaves of *Nardus stricta*, Silpho Moor, near Scarborough, July.

C. Crossland in Naturalist 1915, p. 145 (T. B. Roe).

Anthostomella tomicoides Sacc. Fung. Venet. IV., p. 1 (1875).

Perithecia scattered or gregarious, seated under the blackened, shining epidermis, depressed globose, black, about $\frac{1}{2}$ mm. in diameter, the conical ostiole piercing the epidermis and slightly projecting; asci cylindrical with a short, thick stalk, 90-120μ × 7-10μ; spores obliquely uniseriate, ovoid, unequal sided, truncate at the lower end and provided with a short colourless appendage, 15μ × 8μ.

On decaying herbaceous stalks. Coll. by D. A. Boyd on stems of *Eupatorium Cannabinum*, West Kilbride, Ayrshire, June, 1914.

ROSELLINIA ALCHEMILLAE n. sp.

Peritheciis sparsis vel gregariis, atris, opacis et carbonaceis, epiphyllis, erumpentibus late globoso-conicis levibus, ad basim 300-350μ, vel interdum parviusculis 50-70μ, papillatis, poro tandem lato pertusis; paraphysibus teneribus interne granulosis, contortis, ascos superantibus; ascis cylindraceis, 100μ × 10-12μ; sporis late fusiformibus, utrinque subacutis, monostichis, biguttulatis, c. 17μ × 7-8μ.

Ad folia putrida *Alchemillae alpinae*.

Coll. D. A. Boyd, Glen Falloch, Perthshire, May, 1914.

Mycosphaerella Pelvetiae Suth. in New Phytol. XIV., p. 34 (fig. 1) 1915.

On the receptacles of *Pelvetia canaliculata*, where, according to the author, it lives in symbiotic union with the host. Everywhere on the British Coasts.

Stigmatea Pelvetiae Suth. in New Phytol. XIV., p. 37 (fig. 2), 1915.

Parasitic on the thallus of *Pelvetia* in Scotland.

Pharcidia Pelvetiae Suth. in New Phytol. XIV., p. 39 (fig. 3), 1915.

Parasitic on *Pelvetia* in Britain.

Pleospora Pelvetiae Suth. in New Phytol. XIV., p. 41 (fig. 4), 1915.

At first parasitic on *Pelvetia*, then saprophytic. (Locality not given.)

P. Euonymi Fuck.

On fallen leaves of *Euonymus* sp. South Cliff, Scarborough, March, 1913.

C. Crossland in Naturalist 1915, p. 145. (T. B. Roe.)

Orcadia pelvetiana Suth. in New Phytol. XIV., p. 183 (fig. 1), 1915.

Parasitic on *Pelvetia canaliculata*, Orkney and Clare Island.

Didymosphaeria pelvetiana Suth. in New Phytol. XIV., p. 185 (fig. 2) 1915.

Parasitic on *Pelvetia canaliculata*, Orkney and Solent.

D. fucicola Suth. Tom. cit. p. 188.

Parasitic on *Fucus vesiculosus*, Orkney.

Leptosphaeria Rusci Sacc. Syll. II., p. 74.

On cladodes of *Ruscus aculeatus*, Oxsted, Surrey, Nov., 1914. Previously reported from Kew Gardens.

UREDINEAE.

Puccinia borealis Juel in Ofvers. af. K. Vet. Akad. Förh., p. 413 (1894).

The aecidial stage of this fungus which occurs on *Thalictrum alpinum* was first described by Greville in his Scottish Cryptogamic Flora, I., f. 4 (1823) as *Aecidium Thalictri*. "This beautiful species was discovered on Ben Voirlich by Mr. Patterson, in one of Dr. Hooker's excursions to Ben Lomond and the neighbouring mountains in 1821: since which time I had received a specimen from Mr. Arnott, gathered by Mr. Macritchie in the Highlands." The fungus has been overlooked in the recent British lists of Uredineae. Juel showed that the aecidiospores of *Aecidium Thalictri* Grev. infected *Agrostis borealis*, producing uredospores and teleutospores upon it: *Anthoxanthum odoratum* probably served as a second host. The Ben Voirlich specimen is in the herbarium of the Royal Botanic Garden, Edinburgh. Dr. Malcolm Wilson was unsuccessful in a recent search for the fungus on Ben Voirlich.

M. Wilson in Journ. Bot. LIII., p. 44 (1915).

P. septentrionalis Juel, Tom. cit. p. 383 (1895).

The aecidial stage of this fungus on *Thalictrum alpinum* was described by Johanson from Iceland in 1885 and given the name *Aecidium Sommerfeltii;* he pointed out that it was distinguished from *A. Thalictri* Grev. by the production of its

aecidia on swollen red or violet coloured spots on the stems and leaves of the host plant. Juel, working with material from Norway and Sweden, showed that on infecting *Polygonum viviparum* and *P. Bistorta* with the aecidiospores of *A. Sommerfeltii*, uredospores and teleutospores were produced.

Aecidial stage: Of common occurrence on many of the higher mountains of Scotland. Perthshire, Ben Lui, June 1913, Meall nan Ptarmachan, 1914 (in each case at an altitude of about 2,500 feet). Glen Callater, Aberdeenshire, 1845.

Teleutospore stage. Found in abundance on *Polygonum viviparum* on Ben Lui, Oct. 1914.

"Uredospores were not discovered, but this was no doubt due to the late date at which the specimens were collected. *Thalictrum alpinum* occurred in abundance in proximity to the infected plants, but no sign of the aecidial stage was found; it appears that the portions of the host bearing the aecidium die down before the uninfected parts. *Polygonum Bistorta* is not of common occurrence in the vicinity of the infected *T. alpinum*, and it appears probable that this species does not serve as a host for the fungus in these localities."

M. Wilson, Tom. cit. p. 45.

Melampsora alpina Juel, Tom. cit. p. 417 (1894).

On *Salix herbacea* on Ben Lui, at about 2,500 feet, Oct. 1914. Both uredospores and teleutospores present.

M. Wilson, Tom. cit. p. 48.

The differences between *M. alpina* Juel and *M. arctica* Rostr. seem very slight. The uredosori of the former are described as scattered, whereas those of the latter are gregarious and often cover the whole shoot. Dr. Wilson's measurements of uredospores (19-22μ × 14-17μ) are greater than Juel's (15-18μ): also he finds the paraphyses reach a length of 88μ as against previous measurements in *M. alpina* (30-35μ) and *M. arctica* (50μ).

HYPHOMYCETES.

Cephalosporium Lefroyi Horne in Gard. Chron. Vol. LVII., p. 139 (1915).

Fungus entomogenous, white; sterile hyphae, septate, loosely interwoven or sometimes intricate, 1·7μ-3·4μ thick, bearing capitate conidiophores at short intervals; conidiophores simple, septate or continuous, 17-20μ × 1·7-2·4μ, fastigiate, with an acrogenous, slightly mucilaginous capitulum; capitula globose, ±3·5-7μ diam., thickly beset with spores (fourteen or more); spores hyaline, ellipsoid, ovoid, or oblong, straight or slightly curved, ±7μ × 1-1·7μ.

On *Aleurodes vaporariorum* (white fly), both imago and

larva infesting leaves of *Centropogon* at R.H.S. Gardens, Wisley, Surrey.

Differs from *C. Lecanii* in colour and in dimensions of conidiophores, capitula and spores.

Ramularia arvensis Sacc. in Mich. II., p. 548 (1882). *(Cylindrospora arvensis* Schröt., *Ramularia anserina* Allesch.*)*

Leaf spots almost round, reddish-brown, often becoming white from the middle, often confluent and covering whole sections of the leaflets. Conidiophores emerging in tufts from the stomata, generally unbranched, non-septate, slightly bent, 20-35μ × 2·5-3μ; conidia cylindrical, round at the ends, in short chains, simple with one, rarely two septa, 18-35μ × 2·5-4μ.

On leaves of *Potentilla anserina.* Coll. D. A. Boyd, Colintraive, Argyllshire, Aug. 1913.

R. Campanulae-latifoliae Allesch. in Hedwigia XXXIV., p. 283 (1895).

Leaf spots small, scarcely 1 cm. across, almost round or irregular, greyish-green below, darker coloured above. Tufts generally hypophyllous, small, white, the conidiophores emerging from the stomata, short, simple, with few projections, 30-40μ long, 4-5μ thick. Conidia cylindrical, blunt at the ends, straight, usually 2-3-septate, sometimes slightly constricted at the septa, colourless, 20-40μ × 2·5-4μ.

On fading leaves of *Campanula latifolia*, Largs, Ayrshire. Coll. D. A. Boyd, Sept., 1913.

The spores of the Largs specimen are somewhat wider than the measurements given by Allescher, otherwise the specimens are identical.

R. Cardui Karst. in Medd. Soc. Faun. et Fl. Fenn. XIV., p. 109 (1888).

Leaf spots rather large up to 1 cm. across, whitish grey with a brown margin, often falling out, conidiophores emerging from stomata in dense tufts, irregularly bent, colourless, 45-70μ × 4-5μ; conidia rod-shaped, straight, simple, rarely two-celled, colourless, often in chains, 10-22μ × 2-5μ.

On decaying leaves of *Cnicus arvensis.* Coll. D. A. Boyd, Dalry, Ayrshire, Aug., 1913.

HADROTRICHUM Fuck. Symb. p. 221 (1869).

Conidiophores united at the base in compact masses, rather stout, unbranched, brown. Conidia solitary at the tips, globose or somewhat elongate, one-celled, brown. Parasitic genus. The conidial forms of *Scirrhia* and *Phyllachora.*

H. virescens Sacc. & Roum. in Rev. Mycol. III., p. 56 (1881).

Conidiophores forming linear or punctiform black masses, usually about 2 mm. × 1 mm., somewhat irregular. Conidiophores cylindrical, somewhat clavate, rarely septate, brown, 28-30μ × 7-10μ; conidia globose, brown, smooth, 7-15μ in diam.

On leaves of *Agrostis*. Coll. D. A. Boyd, Dalry, Ayrshire, Aug. 1913.

CERCOSPORA VERONICAE n. sp.

Maculis parvis, c. 500μ diam., zona fulva circumdatis tandem paginam perforantibus caespitulis epiphyllis, numerosis, erectis, septatis, pallido-cinereis, 80-90μ × 3-4μ; conidiis oblongo-ellipsoideis, 17-20μ × 5-6μ, rectis, continuis dein 1-septatis, hyalinis dein pallido-brunneis.

Ad folia viva *Veronicae Chamaedrys*.

Coll. D. A. Boyd, Island of Cumbrae, Buteshire, Aug. 1914.

DENDROSTILBELLA von Höhn. in Oester. Bot. Zeitschr. LV., p. 22 (1905).

Similar to *Stilbum* in outward appearance, but differing in the branched conidiophores.

D. GLABROVIRENS n. sp.

Synnematibus fasciculatis vel singularibus, erectis, viridibus c. 1 mm. altis, c. 50μ crassis, capitulis minutis pyriformibus vel globosis, c. 200μ × 150μ diaphano-viridibus; conidiophoris filiformibus, ramulosis; conidiis ovoideis, perexiguis c. 1μ longis.

In ligno dejecto, Swansea, Sept. 30th, 1915. Coll. Miss H. Smith (Nuneaton).

This fungus was associated with a species of *Corynella* which was considered in the field to be *C. atrovirens*, of which however we have been unable to secure a specimen for microscopic examination. The conidial stage of *C. atrovirens* is pulvinate and sessile, that of *C. glabrovirens* with which we have associated this conidial form is figured in Boudier's Icones Mycol. III., pl. 458, and resembles in outward appearance the specimen here described. *Dendrostilbella prasinula*, a very similar form associated with *Corynella prasinula* differs in the larger size of the head and of the conidia.

Torula epizoa Corda in Sturm, Deutschl. Flora. Pilze II. t. 45 (1829).

Forming small round patches, scattered or coalescent, brown. Conidiophores simple. Conidia in chains, globose.

On fat, &c. On a lubricating grease, "Asbestoline," Cornwall. Sent by Mr. Coon.

The specimen received from Cornwall forms dark and round patches on the grease. The chains are frequently branched and bend in all directions. The conidia are globose, smooth or minutely echinulate and measure about 5μ in diameter.

SPHAEROPSIDEAE.

PHYLLOSTICTA POLEMONII n. sp.

Maculis irregularibus, expansis saepe totum folium occupantibus, brunneis dein griseis; pycnidiis amphigenis laxe gregariis, minutis, immersis, epidermide velatis, 60-90μ diam., pallide brunneis; sporis elliptico-cylindraceis, utrinque obtuse rotundatis, 5-7μ × 2μ.

Ad folia languida *Polemonii* sp.

Coll. D. A. Boyd, Salcoats, Ayrshire, July, 1914.

Macrophoma Falconeri Henn. in Hedw. XLII., p. 219 (1903).

Spots marginal, reddish-brown, fading later. Pycnidia gregarious or scattered, superficially erumpent, hemispherical, black, shining, about 250-300μ in diam.; sterigmata oblong or subclavate, 10-25μ × 3-4·5μ; conidia oblong with obtuse ends, with granular contents or 2-pluriguttulate, hyaline, 15-30μ × 10-14μ.

On the leaves of *Rhododendron Falconeri*, Berlin.

A fungus gathered on the leaves of *Rhododendron Falconeri* at Gower, Swansea, Oct. 1st, 1915, is in our opinion referable to Henning's species described above. There were the following differences however: the spots were not necessarily marginal, the pycnidia were rarely more than 250μ in diameter and the spores seldom measured more than 18μ × 7μ.

CONIOTHYRIUM PTERIDIS n. sp.

Pycnidiis gregariis erumpentibus, subglobosis vel sublenticularibus, atris, carbonaceis, ad 200μ diam.; sporulis ellipsoideis vel subglobosis, fuligineis, continuis, 2·5μ × 1·5-2μ.

In rhacidi et pinnis *Pteridis Aquilinae*.

Coll. D. A. Boyd, Ardrossan, Ayrshire,

ASCOCHYTA PSEUDACORI n. sp.

Maculis elongatis, griseis; pycnidiis epiphyllis, minutissimis, globosis, c. 150μ cr., nigrescentibus; sporis ellipsoideis, uniseptatis, 5μ × 2·5μ.

In foliis languidis *Iridis Pseudacoris*.

Coll. D. A. Boyd, Colentraive, Argyll, Aug. 1913.

Diplodia pinea (Desm.) Kickx. Fl. Crypt. Flandres I., p. 397 (1867). *Sphaeria pinea* Desm. in Ann. Sci. Nat. XVII., p. 14 (1842).

Pycnidia with globose projecting ostiole, black, ovoid, bursting through the epidermis or cortex, more or less gregarious, or often arranged in a sinuate series when corticolous, scattered when foliicolous; ostiole finally deciduous; spores elliptic-oblong, 35-45μ × 16-20μ, simple, yellowish, becoming uniseptate, scarcely constricted and reddish brown.

On the branches and needles of dying *Pinus sylvestris*, Swansea, Sept., 1915.

See also Massee, Diseases of Cultivated Plants and Trees, p. 574, where it is stated that the fungus "attacks the leaves and young shoots of various species of *Pinus* in Europe. The leaves fall prematurely and the shoots are eventually killed, but remain for some years before they fall, and produce annually a crop of spores which infect adjoining branches or trees. The disease is most injurious to nursery stock." Experiments conducted at Kew showed that species belonging to the genus *Pinus* could be readily infected by the spores, whereas species of *Picea, Abies, and Larix* resisted all attempts at infection. See also Board of Agriculture Leaflet No. 199.

STAGONOSPORA ARRHENATHERI n. sp.

Pycnidiis sparsis vel gregariis, immersis, pallide-brunneis, globosis, poro pertusis, minutis, 170-200μ diam.; sporis cylindraceis leniter curvulis vel rectis, utrinque obtusis vel interdum acutiusculis, 3-septatis, hyalinis, non constrictis, 25-35μ × 4μ.

In culmis *Arrhenatheri elatii.*

Coll. D. A. Boyd, Dalry, Ayrshire, Aug., 1913.

Septoria acuum Oudemans in Nederl. Kruidk. Arch. IV., p. 234 (1885).

Pycnidia on both surfaces of the leaf, punctiform, black, immersed under the epidermis, convex, about 230-270μ × 150-200μ; sporophores short, about 8μ × 3μ; spores abundant, cylindrical, simple, 16-18μ × 2-2·5μ.

On leaves of *Pinus sylvestris*, Swansea, Sept., 1915.

The pycnidia of Oudemans' species were not described, but the habitat and spore characters recorded leave no doubt as to the identity of this minute species.

S. Oenanthis Ell. & Ev. in Proc. Acad. Nat. Sc. Phil. 1894, p. 567.

Spots scattered, small, 1-3 mm., white, subangular, definite.

Perithecia few on a spot (3-6), small, 75μ, black, subastomous. Sporules fusoid-cylindrical, hyaline, nucleate, 20-35μ × 1·5-2μ, ends subacute, slightly curved.

On leaves of *Oenanthe sarmentosa*, U.S.A.

Coll. D. A. Boyd, on fading leaves of *Oenanthe crocata*, Island of Cumbrae, Bute, and Ardrossan, Ayr., Aug., 1914.

S. Brissaceana Sacc. et Let. in Mich. II., p. 625 (1882).

Spots small up to 1 cm. across, ochraceous yellow with a darker border. Pycnidia epiphyllous, punctiform, about 100μ across, with an ostiole 25-40μ wide, surrounded by dark brown cells; spores filiform, slightly bent and narrower at the ends, with a few oil drops, or obscurely 2-septate, 25-35μ × 1-1·5μ.

On leaves of *Lythrum Salicaria*. Coll. D. A. Boyd, Stevensten, Ayrshire, July, 1913, and Whiting Bay, Arran, Aug., 1913.

S. LEONTODONTIS n. sp.

Maculis amphigenis albidis et exaridis, c. 1 mm. cr., rotundatis, zona crassa rufobrunnea circumdatis; pycnidiis sparsis, globosis, brunneis, c. 80μ diam., poro pertusis; sporis acicularibus, 25μ × 1μ, uni- vel pluri-septatis.

In foliis *Leontodontis autumnalis*.

Coll. D. A. Boyd. Machrie Bay, Arran, Aug., 1913.

Possibly the same species as *Rhabdospora Leontodontis* Henn. (Hedw. 1904, p. 73), but the latter grows on the dried stalks of *Leontodon* apparently without forming spots.

S. BROMICOLA n. sp.

Maculis obsoletis; pycnidiis amphigenis, subgregariis, minutis, ad 80μ diam., brunneis, poro 20μ lato pertusis; sporis filiformibus leniter flexuosis, utrinque acutis, continuis, hyalinis, 50-60μ × 1μ.

In foliis languidis *Bromi mollis*.

Coll. D. A. Boyd, Machrie Bay, Arran, Aug., 1913.

This species differs from *S. Bromi* Sacc. in the absence of spots, the smaller pycnidia and constantly narrower spores which are not wider at the base.

DISCULA JUNCI n. sp.

Pustulis sparsis, numerosis, sordide brunneis, epidermide pustulata tectis eamque demum disrumpentibus dehiscentibus, contextu supra et infra imperfecto; sporophoris confertis, simplicibus, 5-7 × 1μ, hyalinis; sporulis minutissimis, ·5-1μ, hyalinis.

In calamis *Junci communis*.

Coll. D. A. Boyd, Ardrossan, Ayrshire, Aug., 1914.

The dark colour of the pustules is apparently due to the decaying of the host tissue on which the sporophores are directly seated. Mr. Boyd informs us that this fungus seems to be always found on dead rush stems that have *Sclerotium roseum (Sclerotinia Curreyana)* inside them, and that the sclerotia in *Scirpus lacustris* are also associated with a somewhat similar fungus.

SPHAERIDIUM Fres. Beitr. p. 46 (1852).

Sporodochium globose, sessile or narrowing towards the base to a short stalk, fragile, not mucilaginous; conidiophores upright, rod-like, unbranched or branched; conidia apical in simple or branched chains, cylindrical, colourless.

Differing from *Volutella* in the absence of hairs.

S. FOLIICOLUM n. sp.

Sporodochiis sessilibus, subglobosis vel lenticularibus, confertis, c. 200μ diam., ochraceo-albis; conidiophoris simplicibus inferne arcte fasciculatis, tandem superne in conidia utrinque truncata dein ellipsoidea abeuntibus, 10-15μ × 3-4μ.

Ad folia languida *Salicis pentandrae.*

Coll. D. A. Boyd, Island of Cumbrae, Bute, Aug., 1914.

Gloeosporium Trifolii Peck in 33rd Ann. Report State Mus. Nat. Hist., Albany, p. 26 (1880).

Spots suborbicular often concentrically zoned, brown; spores oblong or cylindrical, obtuse, simple, colourless, 15-22μ × 4-6μ.

On living leaves of *Trifolium pratense,* U.S.A.

Collected on *Trifolium repens,* near Sandsend, Yorkshire, May, 1913 (C. Crossland in Naturalist 1915, p. 145).

G. Helicis (Desm.) Oud. Fung. Neerdl. No. 196.

Spots epiphyllous, dark brown, scarcely bordered. Spore pustules, lentiform, small, yellowish-brown; spores elongate-clavate, somewhat bent, granular, 20μ × 6-7μ, colourless.

On leaves of *Hedera Helix.* Coll. D. A. Boyd, Rosneath, Dumbartonshire, June, 1912.

G. Tiliae Oud. Mat. Myc. Neerl. II., p. 31 (1867). var *maculicolum* Allesch. in Rabenh. Kryptfl. I., 7, p. 504 (1902). *G. tiliaecolum* Allesch. in Ber. Bay. Bot. Ges. V., p. 20 (1897); Salmon and Wormald in Gard. Chron. LVIII., p. 193 (1915).

This fungus has been known for some time on the Continent as causing a serious disease of lime trees. It appeared last

June in a garden at Bearstead, near Maidstone, on *Tilia cordata.*

Allescher gives the spore size as 8-14μ × 4-6μ. Laubert in Zeitschr. Pflanzenkr. XIV., p. 259 (1904) gives the length as 10-18μ, which Salmon and Wormald have verified. According to Allescher and Laubert the only difference between *G. Tiliae* and *G. tiliaecolum* is in the more developed spots of the latter. *Cf.* Trans. Brit. Mycol. Soc. II., p. 55 (1904).

NEW OR RARE BRITISH FUNGI.

By Carleton Rea, B.C.L., M.A.

With Plate IV.

Tricholoma psammopum Kalchbr. Kalchbr. Ic., t. 3, f. 2.

Pileus 3-5 cm. wide, *tawny-brown,* fleshy, convex, minutely squamulose or smooth. Stem 5-7 cm. long, 1·5 cm. thick, *concolorous, granularly punctate* from the breaking up of the epidermis, apex *white,* attenuated at the base. Gills straw or flesh colour, emarginate, ventricose, sub-distant. Flesh white, reddish at the base of the stem. Spores white, subglobose 4-5 × 3-4μ, 1-guttulate. Taste slightly bitter.

Under oaks and conifers, Edlington Wood, Yorkshire, 25th September, 1914, Mr. J. Ramsbottom.

Somewhat resembling small forms of *Tricholoma imbricatum* Fr., but distinguished by the granularly punctate stem and the gills not becoming spotted with red. It has also a superficial likeness to *Lepiota polysticta* Berk.

Omphalia scyphoides Fr. Sys. Myc. I., 163; Hym. Eur. 156, Monogr. I., 181.

Shining white, gregarious, pileus 1-3 cm. wide, *somewhat membranaceous, umbilicate,* then *cyathiform, silky;* margin undulate. Stem 2-6 cm. long, 1-3 mm. thick, solid, base *white strigose.* Gills *very narrow,* 1 mm. wide, decurrent, *crowded.* Flesh white. Spores white, hyaline, pip-shaped, 8-9 × 5μ, with a large central gutta, rounded at one end, pointed at the other. Smell and taste none.

On bare soil in a garden, Bath Weston, Somersetshire, 25th August, 1915, Mr. C. J. Sharpe.

This shining white Omphalia is easily recognized by its

membranaceous, umbilicate pileus becoming cyathiform, and the very narrow gills. Fries in his "Systema" based his description on a plant ranging from 4-8 mm. in width across the pileus, but in his "Hymenomycetes Europaei" he affirms that it sometimes ranges to 2·5 cm. and more, and Quélet gives for the same, 1-2 cm. This is the form that I have previously seen in France.

Lactarius lividus Lamb. Massee Europ. Fung. Flora Agaric. 67.

Pileus convex then plane or depressed, not distinctly zoned, pale livid, centre fuscescent, viscid (?). Stem livid, solid, curved. Gills subdecurrent, pale livid, crowded. Milk white, acrid.

Mulgrave Woods, Fungus Foray, October, 1914. Naturalist (1914) 382 and (1915) 99.

Russula erythropus (Fr.) Peltereau Bull. Soc. Myc. Fr. XXIV. (1908) 118.

Pileus 8-16 cm. wide, *dark blood red*, disc *darker*, decolouring very slightly with age, never tinted ochraceous or olivaceous, convex, then depressed, *firm*, *unpolished;* margin slightly striate when old. Stem 6-10 cm. long, 2-3 cm. thick, *rose-red*, rarely rose-red on one side only, *firm*, equal. Gills white then deep ochraceous, very broad, *attenuated* near the stem, rounded near the margin of the pileus. Flesh cream colour, thin at the margin of the pileus. Spores ochraceous, globose, 8-10 × 8-9μ, echinulate. Taste pleasant.

On the ground, Sneyds Coppice, Worcestershire, 19th August, 1915, C.R.

This species resembles *Russula alutacea* in the toughness of the stem, but differs in the dark blood-red colour of the pileus never becoming ochraceous or olivaceous with age, the dull, unpolished surface of the pileus, and more especially in the attenuation of the gills at their base near the stem.

Lentinus umbellatus Fr., Epicr. 393, Monogr. II., 234, Hym. Eur., 484.

Very much branched fleshy coriaceous, tough. Pileoli very numerous, 1·5-2·5 cm. wide, *becoming yellowish cinereous*, entire, *umbilicate*, smooth. Stems 5-9 cm. long, 3-8 mm. wide, white, caespitosely-connate at the base, *branched*, *sulcate*. Gills *very narrow*, 1 mm. wide, *white*, deeply decurrent, minutely serrated, crowded. Flesh white. Spores white, globose, 4-5μ, with a large central gutta. Smell and taste pleasant.

On an old stump, Nunnery Wood, Worcestershire, 28th August, 1915, C.R.

Looking exactly like *Polyporus umbellatus*, each branch of the stem bearing an umbilicate, regular pileus.

Lentinus auricula Fr. Monogr. II., 237. Hym. Eur. 486, Icon. t. 175, f. 2.

White, becoming tinged with yellow when old, caespitosely imbricate. Pileus 2-4 cm. across, fleshy-coriaceous, *ear-shaped*, *dimidiate*, *oblong*, *ascending*, *sessile*, margin repand, cucullately-revolute beneath. Gills *very narrow*, 1 mm. wide, very closely crenulately-serrated, decurrent to the base, and separate. Flesh white. Spores white, globose, 3-4μ, with a large central gutta.

On a living stump of *Tilia cordata*, Sneyds Coppice, Worcestershire, 19th August, 1915, C.R.

Resembling somewhat small specimens of *Pleurotus porrigens*, but distinguished by its serrate gills.

Pluteus argenteogriseus Rea. Vide t. IV.

Pileus 3·5-4·5 cm. latus, 2·5 cm. altus, *ex niveo griseo-fuscescens*, campanulatus, obtuse umbonatus, *flocculoso-sericeus*, *atomatus;* margine *excedente*, *fisso*. Stipes 6-7 cm. longus, 5-6 mm. crassus, pileo *concolor*, incurvus, striatus, farctus, basi bulbosus. Lamellae 11-12 mm. latae, ex albo carneae, confertae, liberae, ventricosae. Caro alba, inodora et insapora. Sporae roseae, globosae vel ellipticae, $6 \times 6\mu$ vel $7\text{-}8 \times 6\mu$, uni-multi-guttulatae. Cystidia nulla.

Ad ligna mucida, Epping Forest, Essex. Legit A. D. Cotton, 17-ix.-1914.

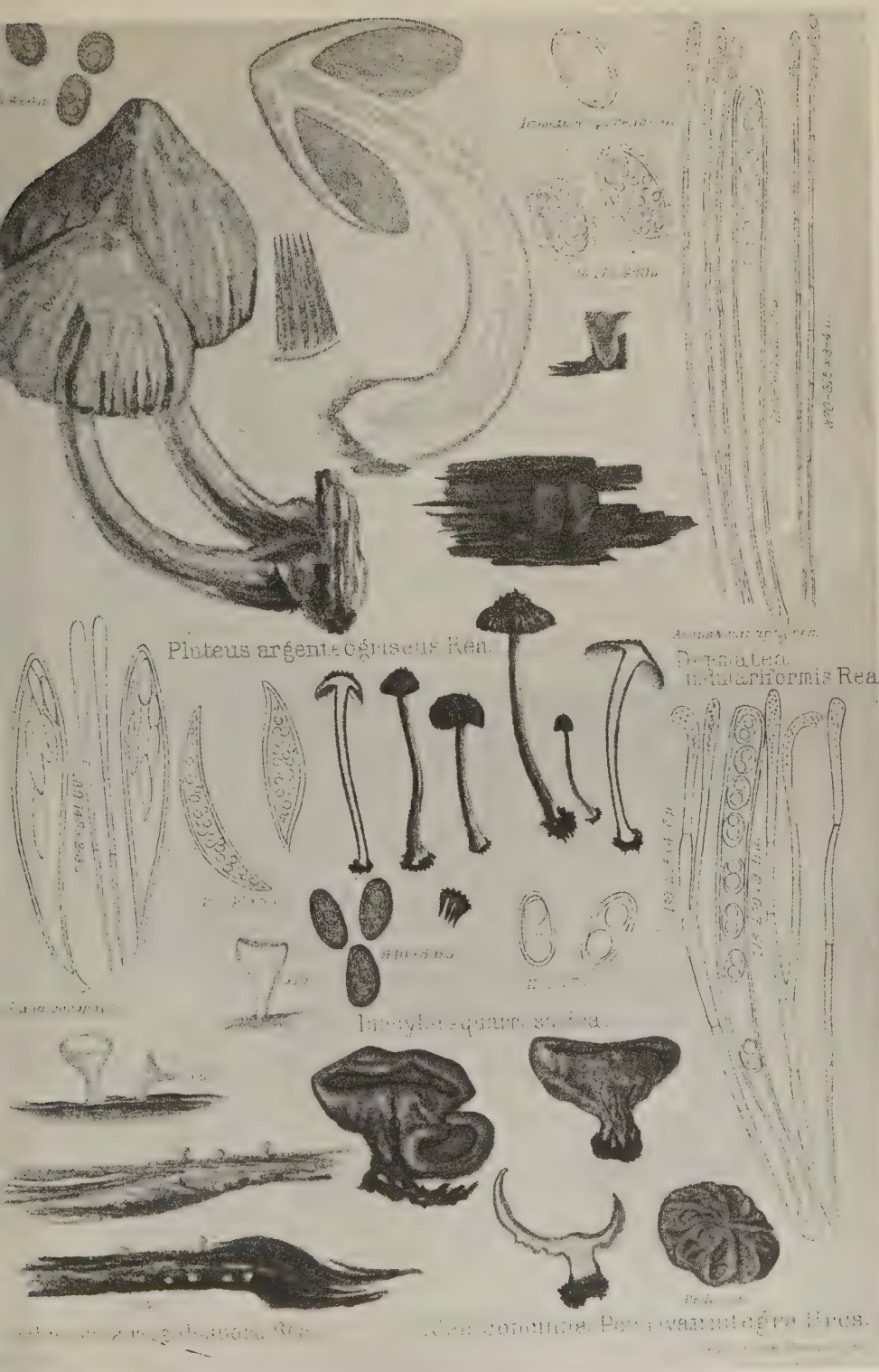
Characterized by the pure white, atomate pileus finally becoming fuscous grey, the margin of the pileus exceeding the gills and the broad gills.

Inocybe squarrosa Rea. Vide t. IV.

Pileus 5-13 mm. latus, campanulatus vel convexus, murino-ochraceus, floccoso-fibrillosus, *disco squamis floccosis saturatioribus squarrosus;* margine primo involuto, albo. Stipes 1·5-3 cm. longus, 1-2 mm. crassus, incarnato-albus, solidus, apice pruinoso, basi albo, subbulbilloso. Lamellae 2 mm. latae, ex albo fuscescentes, acie alba, sinuato-adnatae. Caro alba absque odore et sapore speciali. Cystidia *nulla*. Sporae chlorino-fuscae, ellipticae, $9\text{-}10 \times 5\text{-}6\mu$, 1-guttulatae.

Ad terram sub salicibus et alnis. Lower Grimley, Worcestershire. Legit W. B. Allen, 18-vii.-1915.

Easily known by its small size and the revolute brownish scales on the pileus.


Pluteus argenteogriseus Rea.
Inocybe squamosa Rea.

Naucoria Wieslandri Fr. Monogr. I., 385, Hym. Eur. 264.

Pileus 2-4 mm. broad, *tawny*, somewhat fleshy, convex then plane, obtuse, smooth, cuticle areolately-rivulose, hence the surface is spotted with *crowded darker papillate warts*. Stem 5 cm. long, 1-2 mm. thick, *becoming black*, *filiform*, *fistulose*, flaccid, *almost naked*. Gills at length dark ferruginous, adnate, broad.

On the ground among short grass, Mulgrave Woods. Fungus Foray, September, 1913. Naturalist (1914) 145.

Galera flexipes Karst. Myc. Fenn. III., 372.

Pileus 1-1·5 cm. broad, fleshy-membranceous, *ferruginous*, ochraceous when dry, campanulate, obtuse, pellucidly striate when moist. Stem 2-3 cm. long, 1·5 mm. thick, pallid becoming ferruginous, white-fibrillose, apex white pruinose, equal, fistulose, flexuose. Gills pallid becoming ferruginous, adnate, crowded, *edge crenulate*, oblong. Spores 10-12 × 5-6μ.

Among grass in open place, Mulgrave Woods. Fungus Foray, September, 1913. Naturalist (1914) 145.

Boletus albidus (Roques) Quél. Roques Champ. com. et vén. t. 8, f. 2. Quél. Fl. Myc. 424.

Pileus 6-9 cm. wide, *whitish*, with a slight greenish tinge, convex, subtomentose. Stem 6-7 cm. long, 3-4 cm. thick, *pale citron yellow*, ventricose, finely *reticulated with veins*, which become brownish on handling. Pores *pale citron yellow*, orifice round. Flesh cream colour or pale citron becoming blue when cut or broken. Spores boat shaped, 10-11 × 4-5μ, 1-2-guttulate, deep ochre.

In a pasture ten yards away from a beech and birch coppice, Inchbrook, Woodchester, Gloucestershire, 21st July, 1915, Mr. Basil P. Marmont.

This Boletus somewhat resembles *Boletus candicans* Fr. (*lacteus* (Lév.) Quél.) but differs in the reticulately veined, pale citron yellow stem and yellow tubes.

Fomes roburneus (Fr.) Lloyd. Lloyd Synopsis of the genus Fomes, 246.

"A form of *Fomes nigricans* Fr. It is exactly the same, excepting there is a *slight resinous exudation* on the crust and the setae are quite abundant. The pore mouths are *strongly silvery, glancing*." Spores hyaline, globose, 6μ.

On willow, Pyrford, Surrey, 6th January, 1914, Lady Davey. This determination was kindly made by Mr. C. G. Lloyd.

Poria eupora Karst. Myc. Fenn. III., 273.

Effused, adhaerent or adnate, thin, somewhat shining, circumference byssoid, white; margin *at length free, glabrous.* Pores *bright buff* or yellow, minute, short, round, or somewhat angular. Spores hyaline, elliptical, 3-4 × 1·5-2μ.

On a decorticated log, near the Double View, Forest of Dean, Gloucestershire, 1st June, 1914, Miss E. M. Wakefield.

I am indebted to Miss E. M. Wakefield for kindly determining this species. It was subsequently found at the autumn foray in the Edlington Wood, Doncaster, and I have since met with it on fallen logs and decorticated branches in Nunnery Wood, Shrawley Wood, Monk Wood, and Wyre Forest, Worcestershire.

Coniophora laxa Fr. El. 196; Quél .Fl. Myc. 3. Berk. Out. 269.

Specimens of this somewhat uncommon *Coniophora* were sent me by the Rev. J. Harvey Bloom, gathered in his garden at Whitchurch Rectory, Warwickshire, 17th December, 1915. The spores are deep ferruginous when deposited in mass on black paper, elliptical, 10-11 × 6-7μ, minutely punctate. The basidia have 2-4-sterigmata.

PHLEBIA ERECTA Rea.

Effusa, erecta, clavata, ceracea; clavulis cylindraceis, 1-3 cm. longis, 2-3 mm. crassis, apicibus obtusis vel acutis, levibus, ex *valde incarnata nigrescentibus,* basi albo-flocculosis. Sporae hyalinae, reniformes, 4-5 × 2-3μ, 2-guttulatae.

Inter muscos ad terram deustam juxta truncos adustos *Pruni spinosae.* Near the Paradise, Crimscote Downs, Whitchurch, Warwickshire, 25th October, 1915, Rev. J. Harvey Bloom.

Distinguished by its *erect, Clavaria-like* habit.

Merulius papyraceus Fr. El. 62, Hym. Eur. 595.

Widely effused, resupinate, *umber ferruginous,* circumference paler, *of the consistence of paper, tough, dry, glabrous.* Folds reticulato-porous, pores equal, dilated. Spores ferruginous, elliptical, 8-10 × 6-7μ, 1-2-guttulate.

On an old worked beam amongst grass, near the Chapel, Sketty Park, Glamorganshire, 28th September, 1915, C.R.

Easily recognized by its papery consistency, ferruginous umber colour and coloured spores.

Stereum Chailletii (Pers.) Fr. Pers. Myc. Eur. I., 125 under *Thelephora.*

Broadly effused, coriaceous, resupinate during the first year, then becoming *stratose* and at length pileate, pilei sometimes

well developed, tomentose, sulcately and concentrically zoned, somewhat fawn colour. Hymenium *pale ferruginous*, or *fawn colour, pubescent, velvety*. Spores hyaline, elliptical, inaequelateral, 6-7·5 × 3-4μ. Cystidia *fusiform, cylindrical, yellowish, rough*, 50-120 × 4-5μ, or in old stratose plants 45-60 × 5-7μ.

On a felled oak trunk, Shortcross, Hessenford, Cornwall, 17th November, 1915, Dr. A. Adams.

This Stereum was kindly identified by Miss E. M. Wakefield. Persoon recorded it as growing on *Taxus*, and the Abbé G. Bresadola also found it on *Abies* and *Pinus*. The measurements of spores and cystidia are those given by Bresadola. Spores were not found in the present specimens.

Corticium microsporum (Karst.) Bourd et Galz. Bull. Soc. Myc. Fr. XXVII. (1911) 241. *C. byssinum* Karst. var. *microspora* Bres. Ann. Myc. I. (1903) 76.

Irregularly effused on rotten wood, very thin and fragile. Hymenium when perfect smooth, forming a delicate pellicle, cream, with sometimes a faint pinkish tinge, often imperfect or cracked, showing the delicate white subiculum. Margin white, indefinite. Basidia 4μ wide, with 2-4 sterigmata. Spores hyaline, minute, subglobose, 2μ in diameter, or 3 × 2μ, often with a small oil drop. Subhymenial hyphae 1-2μ in diameter. Basal hyphae 3-5μ, with clamp connections, sometimes encrusted with crystals.

Naturalist (1914) 251-252.

Tomentella subfusca (Karst.) von Höhn & Litsch. in Sitzungsber der k. Akad. der Wissensch., Wien, Mathem-naturw. Kl., Bd. CXV., Abt. 1 (1906) 1572. *Hypochnus subfuscus* Karst., Hattsv. II., 163.

Hymenium dark purplish-brown, between Ridgways "Natal Brown" and "Bone Brown," pulverulent, when seen under a lens closely resembling in habit a Hyphomycete such as *Botrytis*. Margin indefinite, not paler in colour than the hymenium. Basidia clavate, 10-12μ in diameter towards the upper end, with 2-4 curved sterigmata. Spores globose, sepia, aculeate, 8-9μ in diameter without the spines; spines hyaline, acute, 1-2μ long. Subhymenial hyphae pale, 5-7μ in diameter. Basal hyphae brown, thick-walled, straight, with branches coming off at right angles, 7-8μ in diameter, sometimes slightly encrusted with particles of mineral matter. Clamp connections present.

On bark of fallen logs, Cillibion Plantation, Gower, 1st October, 1915, Miss E. M. Wakefield.

Distinguished from *Tomentella fusca* by the darker colour

of the hymenium, the absence of a paler margin, and the more delicate, pulverulent appearance. The spores also are regularly globose, instead of angular, larger and have longer spines than those of *T. fusca.*

Miss E. M. Wakefield kindly determined the specimen and furnished me with the above description.

Tulasnella incarnata Juel. in Bihang K. Sv. Vet.-Akad. Handl. Bd. 23, Afd. III., No. 12 (1897) 22. *Pachysterigma incarnata* Johan-Olsen in Brefeld Untersuchungen, Heft 8, (1889) 7. ? *Corticium incarnatum (pinicola)* Tul. in Ann. sci. nat. 5 sér, XV. (1872) 227.

Forming very thin, bright pink, irregular, small patches on the bark. When well developed the hymenium is fairly continuous and the texture membranaceous. Basidia obovate or clavate, 9μ in diameter at the widest part. Sterigmata (or sessile spores according to Juel.) usually 4, but sometimes 3 or 5, at first obovate or elliptical, 10-13 × 5-7·5μ, at length with a terminal elongation, 7-17 × 1-2·5μ. Spores (conidia of Juel.) hyaline, pyriform or pip-shaped, 8-11 × 5-7μ Hyphae 3μ in diameter.

On fallen branches of oak, Skewen, 30th September, 1915.

I am indebted to Miss E. M. Wakefield for the determination of the specimen and for kindly furnishing me with the above description.

Uromyces striatus Schröt.

On *Trifolium procumbens*, Hollerday Hill and Lynbridge Lane. Norman G. Hadden. Uredinales of North Devon, Journal of Botany LIV. (1916), 53.

Puccinia tinctoriicola Magn.

This Puccinia, according to Grove in British Rust Fungi, 139, has only been gathered at Belton Wood, Highgate, by the late M. C. Cooke. In company with Mr. Gaut, a good many specimens were secured on the Marsh Common, Defford, Worcestershire, on the 1st of September, 1915, both in the uredospore and teleutospore condition. Our member, Mr. Norman G. Hadden, also forwarded to me in August last some nice specimens from the neighbourhood of Lynton, Devonshire. Its host is the somewhat widely distributed *Serratula tinctoria*, so it is probable that its occurrence has been overlooked.

Puccinia Virgaureae (DC.) Libert.

On *Solidago Virgaurea*, Summerhouse Hill, Norman G.

Hadden, Uredinales of North Devon, Journal of Botany LIV. (1916), 53.

Puccinia Crepidis Schröt.

On *Crepis virens*, near the Station and near Brendon, Norman G. Hadden, l.c. 53.

Puccinia Hydrocotyles (Link) Cke.

On *Hydrocotyle vulgaris*, Braunton Burrows, Norman G. Hadden, l.c. 53.

Melampsorella Blechni Syd.

On *Blechnum Spicant*, Watersmeet, Norman G. Hadden, l.c. 54.

Uredo Quercus Brond. *(Cronartium Quercuum* (Berk.) Miyabe*)*.

On *Quercus Ilex*, Hollerday Hill, Norman G. Hadden, l.c. 54.

Morchella elata Fr. var. *purpurascens* (Krombh.) Boud. Icon. III., t. 214, IV., 111.

Pileus 5-8 cm. high, 3 cm. wide at base, rose-lilac or pale purplish, oblong, separated from the stem by a distinct groove, primary pits extending from the apex to the base, often slightly anastomosing, ribs at first paler in colour then becoming blackish, secondary pits somewhat irregular and distant. Stem 6-14 cm. high, 2·5-3 cm. thick, concolorous, cylindrical, or slightly thickened and furrowed at the base, everywhere furfuraceous. Paraphyses branched, hyaline, septate, generally shorter than the asci, 280-310 × 9-12μ. Asci large, rather wide, flexuose at the slightly attenuated base, 8-spored, operculate, 330-375 × 25-27μ Spores elliptical, 21-27 × 12-16μ.

In sandy soil, near Arrochar, Dumbartonshire, 15th April, 1915, Miss Connie Morris.

Differing from the type in its *purplish* colour. The type is characterized by the *oblong* pileus, the *straight ribs* extending from the apex to the base of the pileus and the *somewhat indistinct horizontal ribs*. Mr. Greenwood Pim records the type from Ireland, but a photograph of the same in my possession does not accord with Boudier's description.

Otidia concinna (Pers.) f. *integra* Bres. Fung. Trid. II., 70, t. 183, f. 1, and see plate IV.

Ascophores 1·5-3 cm. wide, ·5-1·5 high, densely gregarious, scarcely somewhat caespitose, cups hemispherical then plano-

concave, entire or very rarely split at the side and ear-shaped; hymenium isabelline or reddish flesh colour, smooth becoming tuberculate; externally pubescent and at length reticulately rugose, *bright citron yellow;* stem short, root-like, white, *costately ribbed, the ribs branched on the exterior of the cup, like Acetabula vulgaris.* Flesh yellowish becoming white. Asci cylindrical, gradually attenuated to the base, 175-230 × 8-11μ, no blue reaction to iodine. Paraphyses branched, apex clavate, straight or curved, 180-235 × 4-6μ, septate. Spores elliptical, 10-13 × 5-6μ, 2-guttulate.

On the ground in woods near Eglinton Castle, Ayrshire, 28th August, 1915, Mr. D. A. Boyd.

This Discomycete is readily known by the bright lemon yellow colour and the branched anastomosing ribs on the exterior of the cup and stem.

OMBROPHILA MEGALOSPORA Rea. Vide t. IV.

Ascomata 1-2·5 mm., rarissime 4 mm.lata, e candida incarnata, demum nigrescentia, cupuliformia, e convexo explanata, humida subgelatinosa demum cartilaginea; stipes 1 mm. alta; ·3-·5 mm. crassa. Asci clavato-subfusoidei, 120-135 × 12-13μ, basi attenuati, 8-spori, foramine marginato, iodo haud tincti; sporae hyalinae, naviculares, saepe curvulae, utrinque attenuatae, 27-30 × 6μ, monosticae vel disticae intus minute granulosae. Paraphyses ascos excedentes, adglutinatae, sursum leniter incrassatae, 130-145 × 2-3μ, septatae, apice intus granulosae.

Ad folia emortua *Caricis inflatae* prope Inver., Dunkeld, Perthshire, Legit Charles McIntosh, 1-viii.-1915.

Easily recognized amongst the white species of Ombrophila by its *large pointed* spores.

DERMATEA NIDULARIFORMIS Rea. Vide t. IV.

Ascomata solitaria, vel parce subcaespitosa, 8-10 mm. alta, 5-8 mm. lata, color valde mellea vel valde succinea, turbinata vel obconica, *nidulariformia*, sessilia, basi attenuata, humida ceraceo-gelatinosa demum cartilaginea, extus leviter furfuracea. Asci cylindracei, basi sensim attenuati, 260-300 × 12-15μ, 8-spori, iodo operculo-immarginato caeruleo-tincti; sporae hyalinae, ellipticae, 14-17 × 9-10μ; diu leves, *demum verrucosae*, monosticae. Paraphyses ascos excedentes, 270-315 × 3-4μ, septatae, apice leniter incrassatae et granuloso farctae.

Ad ligna et ramos decorticatos, Monsaldale, Derbyshire, Legit A. D. Cotton et H. Harrison, 25-v.-1915.

Easily known by its *Nidularia-like* shape and the spores becoming finally verrucose.

Melanospora chionea (Fr.) Cda.

Perithecia scattered or gregarious, superficial, globose, 300-350μ in diam., covered with long, soft, white, woolly hairs; beak long, rigid, curved, transparent, yellow, apex-fringed, white. Asci clavate, 45-48 × 16-17μ, 8-spored. Spores heaped together, or indistinctly 2-seriate, elliptically globose, rounded at both ends, 10-12 × 9-10μ, brown, 1-guttulate.

On pine needles, near Dunkeld, Perthshire, 19th April, 1914, Mr. James Menzies.

This somewhat rare Pyrenomycete has been found by Dr. Carlyle at Orton Moss in 1886 and subsequently at Bulmer, Yorkshire.

ADDITIONAL NOTES ON MARINE PYRENOMYCETES.

Plate V.

By Geo. K. Sutherland, M.A., B.Sc.

ROSELLINIA LAMINARIANA nov. sp. (t. V., fig. 1-3).

Perithecia vel immersa et mature erumpentia vel ab initio in superficie densis hyphis crescentia, globosa, peridio crasso, ostiolo conico, primo eminentibus hyphis tecta, antequam maturescunt nuda, 350-450μ diam.; asci cylindracei, longissimi, apicibus obtusis, octospori, 150 × 15μ; sporidia monosticha, ellipsoidea vel ovoidea, primo annulo mucilagineo circumdata, colore fulvo vel nigro, plerumque guttam magnam olei exhibentia, 20-22μ × 12-14μ; paraphyses crassae et articulatae, mature deliquescentes.

Hab. In thallo *Laminariae*, Dorset.

This species was found first on fronds of *Laminaria*, collected near Lulworth Cove. It occurred along with profuse growths of *Cladosporium algarum*, and appeared later amidst the first impure cultures of that saprophyte. Its quick growth enabled it to be separated readily and thus studied under culture conditions, as well as in the natural state on the thallus. The mycelium, hyaline when immersed and light brown when exposed, varies in diameter from 2-10μ. Its rapid growth enables it to form more or less dense webs of interlacing hyphae over the surface of moist fronds; in dry weather its

growth is limited and mainly in the substratum. Under favourable conditions the marginal hyphae may grow about one inch per day.

Perithecia begin to appear very soon, either in the superficial layers of the substratum or on the surface web. Their progress is rapid. The small immersed forms are pushed through the covering layers and finish their development, either on the surface, or with their basal portion slightly sunk in the frond. In three weeks from infection the perithecia have reached maturity. When first pushed through the substratum, they are seen to be covered with somewhat stiff, radiating, dark-coloured hyphae, which give them a bushy appearance. These gradually disappear, so that the mature peridium is smooth and black. At that stage the perithecium possesses a very distinct ostiole, which may vary from a short wart-shape to the long, conical form shown in Plate V., fig. 1b. Occasionally two ostioles appear on the same fruiting body. Although normally straight, bent ostioles are frequent. This is more characteristic of the genus *Sordaria*, but also occurs in *Rosellinia, e.g., R. Niesslii.* The thick, dark carbonaceous peridium is lined by numerous periphyses in the ostiole region. Until these have broken down or been pushed out, spore dispersal is prevented.

The long, cylindrical, blunt tipped asci, encased by hyaline, jointed paraphyses, fill the body. The swelling of the latter in moist conditions doubtless aids in spore dispersal. The walls of the asci are thin, but fairly persistent. The uniseriate ascospores are elliptical or ovate and dark brown or black. In the immature state they are surrounded by a mucilaginous ring, which seems to disappear later. A large conspicuous oil globule, characteristic of many species of *Rosellinia*, is also present.

This species shows characters which make it almost intermediate between *Rosellinia* and *Sordaria.* The elongated ostiole, occasionally bent, is of more frequent occurrence in the latter genus. The conical type, however, is found in several species of the former, *e.g.,Rosellinia medullaris*, *R. malacotricha*, and *R. Niesslii.* In the last it is also distinctly curved, as in the species under consideration. The mucilaginous ring, usually regarded as a *Sordaria* characteristic when retained in the mature spore is found in several species of *Rosellinia, e.g., R. abscondita*, *R. Niesslii*, etc. When we take into consideration the habit of the perithecium, its carbonaceous and brittle nature, the persistent walls of the ostiole and the tufted hairy coating, found in so many species of *Rosellinia*, there seems little doubt that the species should be placed in that genus, rather than in *Sordaria.*

While this is the first species of *Rosellinia* to be described

as occurring on marine algae, a form with a somewhat analogous habit is found associated with gelatinous algae on marshy ground, e.g., *R. palustris*.

LULWORTHIA nov. gen.

Perithecia primo immersa postremo libera, magna, globosa, sine ostiolo evidenti; asci clavati vel fusiformes, raro cylindracei, parietibus tenuibus, octospori, aparaphysati; sporidia longissima, curvata, hyalina, continua, apicibus brevibus et hyalinis.

LULWORTHIA FUCICOLA nov. sp. (t. V., fig. 4-7).

Perithecia sparsa vel trina quaternave eodem loco crescentia, primo immersa postremo partim libera, in superiore parte carbonacea contextu denso, in inferiore parte rariore contextu, hyalina mollia, globosa vel leniter complanata, sine ostiolo evidenti, 350-450μ; asci crebri, clavati vel fusiformes, parietibus tenuibus, octospori, 90-120μ × 15-20μ, aparaphysati; sporidia longissima utrinque leniter attenuata, cum apicibus brevibus hyalinisque, curvata, hyalina, continua 70-100μ × 4·5-5·5μ.

Hab. In thallo vivo *Fuci vesiculosi*, Dorset.

So far this species has only been obtained once on the older stalk-like portions of the thalli of *Fucus*. The specimen described was collected at Durdle Door on the Dorset coast.

The first sign of attack is the occurrence of numerous, small, discoloured spots on the lower portion of the thallus. These become brown and at the same time perithecia are seen forming beneath the rind. With the gradual decay of the overlying tissue, these emerge and expose their upper portion as in plate V., fig. 4. The mycelium is localised more or less in the outer, cortical layers, and consists of very fine, much-branched hyphae, which cause the death and decay of the infected region. The mature perithecia are large, almost 0·5 mm., globose, or somewhat flattened, and usually without any trace of a neck-like ostiole. Only in the more mature forms does the tip seem to become pierced to form an opening. The exposed portion of the peridium is black, thick-walled, and carbonaceous; the immersed base which consists of loosely woven, delicate hyphae, remains soft-walled and almost hyaline.

The clavate or pointed asci are present in large numbers, but so far no trace of paraphyses has been found, even in the youngest stage examined. The asci possess very thin walls, which break down readily, setting free the spores, some time before they are dispersed. These elongated, hyaline and continuous bodies with short tips (Plate V., fig. 7) are curved and tapering, as shown in Plate V., fig. 6.

Before forming a new genus for this species every effort was made to place it, if possible, in an existing group. The type and habit of the perithecia and asci confine it to the Mycosphaerellaceae or the Pleosporaceae. The absence of paraphyses should, under our present classification, separate it from the latter, but, since occasional forms devoid of paraphyses have been placed under its genera, when they showed marked resemblance in other more essential characters, the possible relationship to this family has also been taken into consideration. Among the Mycosphaerellaceae it approaches most nearly to *Massalongiella*, but the important differences in the spores added to those in the perithecia are sufficient to exclude this genus. Among the possible genera in the Pleosporaceae are *Dilophia*, *Metasphaeria* and *Ophiobolus*. Since there appears to be considerable uncertainty as to the occurrence of paraphyses in *Dilophia*, the species under consideration may be held to share with it this absence of paraphyses in addition to an external resemblance in spores. However, the type and habit of the perithecia, the asci, the continuous spores and appendages render its inclusion under *Dilophia* objectionable. It might be held that *Lulworthia* was a form of *Metasphaeria* in which septa have not developed. But, while it resembles that genus somewhat in the type of perithecium and also in the possession of elongated spores, the attenuated, long, continuous spore with its hyaline tips, added to the absence of paraphyses, render that view untenable, even if we take into consideration *Metasphaeria? Peltigearum* (Arnold). This species has long, continuous spores, but its inclusion in the genus is open to question.

The possibility of any connection with *Ophiobolus* has also been considered, but, apart from mere length of spores, there is little in common. It is true that under *Ophiobolus* there have been included one or two forms with continuous spores, e.g., *Ophiobolus Xanthii* and *O. adnatus*. The position of these has, however, been questioned. But, even apart from the question of the continuous spore, the other characters are sufficiently distinct to make any connection extremely improbable.

The absence of any trace of clypeus or pseudostroma disposes of any spore resemblance to *Linospora* without taking any other differences into account.

It has been only after a careful comparison with possible genera that the writer has been impelled to admit the necessity for this generic separation.

PLEOSPORA LAMINARIANA nov. sp. (t. V., fig. 8-10).

Mycelium diffusum; perithecia primo tota immersa, postremo

erumpentia et partim libera, globosa, ostiolo brevissimo, contextu denso, atra, membranacea, 250-350μ diam.; asci cylindracei parietibus crassis, octospori, 100-110μ × 25μ; sporidia ellipsoidea vel ovoidea, flava vel fulva, muriformia, plerumque septem transversa et complura directa septa habentia; paraphyses filiformes, mature deliquescentes.

Hab. In thallo *Laminariae*, Dorset and Orkney.

This species has been found only on the cast up fronds which strew the zone above tide-mark, and would appear to be entirely saprophytic. It usually accompanies the other saprophytes of this zone, e.g., *Cladosporium algarum* and *Diplodina laminariana*, from which its mycelium is distinguished by the immersed portions being always dark-coloured. Soon after infection the thallus becomes riddled with a strong growth of much branched, stout, brown hyphae. These form small, coiled masses beneath the rind, in which the perithecia take their origin. Even in this early stage the thick, dark wall is present. Inside this there is a more or less homogeneous mass of soft-walled hyaline cells, in the middle of which the young asci appear as in Plate V., fig. 8a. As the perithecia grow, they break through the covering rind and become partially superficial; a few may remain entirely immersed in the thallus and would appear to liberate their spores only on its disintegration.

In the early stages the asci are encased by numerous filamentous paraphyses, which usually disappear in the gradual crushing out of the parenchyma-like packing tissue, as the asci develop. The mature perithecia are irregularly globose and devoid of any neck-like ostiole, a feature which helps to differentiate them from the much smaller perithecia of *Pleospora Pelvetiae*. The asci are few in number, cylindrical and thick-walled, with eight irregularly biseriate spores. The paraphyses have usually disappeared before these reach maturity. The spores elliptical or ovate and at first yellow, become darker and muriform. Finally they possess seven transverse and a varying number of longitudinal septa. Many, however, have only five or six cross walls. In this connection it may be mention that an examination of several species of *Pleospora* has led to the conviction that the value laid upon the number of transverse septa as a specific character, has been over-rated. In the species studied the number seven is obtained finally in the following manner. The young spore divides first into two cells, then each of these again into two, thus giving three septa, easily distinguishable in the mature spore by their thickness and also by the greater constriction at their margins. Then all of these four cells, or any one or more may become transversely divided. There appears to be no definite order in the division of these, except that the two central ones usually de-

velop septa first, and that the terminal two frequently do not show them at all. Consequently the mature spores of the same species may possess seven, six, five or even four septa.

Pleospora laminariana has always been found accompanied by numerous pycnidia of the *Phoma* type which arise from a similar, if not from the same mycelium. Both these and their conidia differ from the description and measurements given for *Phoma Laminariae* Cooke and Massee, *e.g.*, the conidia are only about half the size, but as no type of that species has been available, the consideration of this pycnidial form may be postponed. The writer, however, is of the opinion that the original *Phoma Laminariae* represents the immature, continuous conidia of *Diplodina laminariana*, with whose measurements and description it agrees.

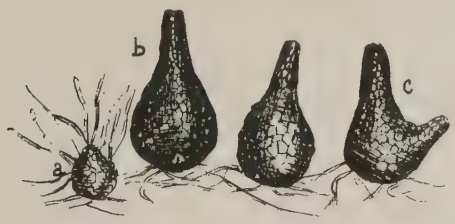
Species of *Orcadia* on *Fucus* (Plate V., figs. 11-14).

An examination of a blackened patch on the older thallus of a species of *Fucus vesiculosus* revealed the presence of a species of Orcadia, which is intermediate in asci and spore measurements between *Orcadia Ascophylli* and *O. pelvetiana*, while differing from both of them in its smaller perithecia. These are only 80-90μ in diameter, with long ostioles varying from 80-120μ × 20-25μ. As those of *O. Ascophylli* are 160-200μ and *O. pelvetiana* 110-140μ, it would appear to be sufficiently distinct to be regarded as a separate species. But as the asci and the spores resemble those of *O. pelvetiana* very closely, a study of further material and of its life history appears desirable before making a definite assertion. At the present time it is intended merely to note its presence on *Fucus vesiculosus* and to give a brief description for comparison with the two species already described.

The perithecia are immersed with the exception of the tip of the ostiole which may project from 5-10μ. The peridium is invariably hyaline and soft-walled, consisting of the loosely woven structure characteristic of the genus. Its globose body averages about 90μ in diameter, with an ostiole from 90-120μ long × 20-25μ broad. The asci are clavate or fusiform, thin-walled, 60-70μ × 10-14·5μ. They are mixed with numerous, attenuated, filamentous paraphyses, which possess dilated tips. The ascospores, spindle-shaped, hyaline, 3-septate, and thick-walled, are about 35 × 5μ, and break up readily into one-celled portions.

EXPLANATION OF FIGURES, PLATE V.

1. Perithecia of *Rosellinia laminariana;* a, immature perithecia with hairs.
2. Asci.



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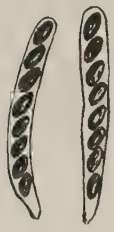
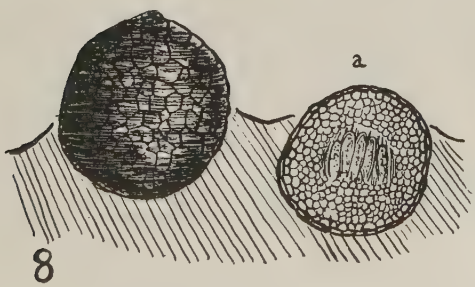


2

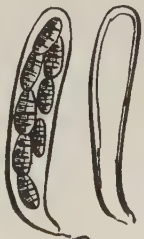
3

4

5 6 7

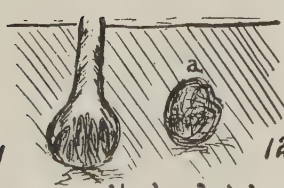


8



9

10



11

12

13

14

G. K. Sutherland del.

1-3. Rosellinia laminariana. 4-7. Lulworthia fuciicola
8-10. Pleospora laminariana. 11-14. Orcadia ? sp.

3. Ascospores.
4. Perithecia of *Lulworthia fucicola*, showing carbonaceous upper portion and soft-walled base.
5. Ascus.
6. Ascospores.
7. Ends of ascospores, enlarged to show hyaline tips.
8. Perithecia of *Pleospora laminariana;* a, immature perithecium with young asci.
9. Asci.
10. Ascospores.
11. Diagram showing Perithecia of *Orcadia;* a, coiled hyphae of young perithecium.
12. Perithecium, showing woven peridium.
13. Asci and paraphyses.
14. Ascospores.

COLOUR STANDARDS.

By J. Ramsbottom, M.A., F.L.S.

During the past ten years there have been published three schemes of colours: Oberthür and Dauthenay's "Répertoire de Couleurs," Klincksieck and Valette's "Code des Couleurs," and Ridgway's "Color Standards and Color Nomenclature." These three works have been adopted by different naturalists, and it has seemed to the British Mycological Society that the question of a colour standard is one that might profitably be brought to the notice of the Affiliated Societies of the British Association.

As everyone who has had to deal with colour in the natural sciences realises, there are two fundamental difficulties: (1) the difficulty of understanding what is intended by any colour term used in a description; (2) the difficulty which any worker himself has of satisfactorily naming the colours in a species under discussion.

It is obvious that these difficulties have not come forward suddenly during the present century, and in the few days at my disposal I have attempted to trace out various previous attempts to get over the difficulty. In this way it would appear that the requisites of a standard could best be appreciated.

The earliest efforts to define colours from the naturalist's standpoint to which I have found a reference is in an Appendix to Charleton's "De Nominibus Animalium," 1677. This author realises the almost infinite varieties of colours, and the difficulty of translating classical names into English idiom. He divides the colours up into groups: white, black, yellow, blue, and so on. He gives Latin names for the colours, e.g., *Psittaceus* is described as "Poppin-jay-green, such as the green of parrats, which in old English were call'd Pope-jayes, quasi Priests-jayes." This method of describing colour by referring it to some natural object has always been common with men of science, and has much to commend it. When one gets away from common objects, however, in the definition of colour obvious objections arise. The more perfect the scheme in any branch of science, the more difficult is it of general application.

The alternative method is to have samples of colour for comparison. It is to such scales we must look if we are to have a satisfactory scheme of denoting colours. Such colour charts have been brought forward at different times. The first colour chart of this description appears to have been published in Haynes' "Termini Botanici Iconibus Illustrati," 1807. There are thirty-six samples of colour which have Latin names appended. In the text the terms are explained, with examples where possible, and the German equivalent given. Next Werner's "Nomenclature of Colours," as introduced by Patrick Syme, was published in 1814; a second edition of this work was published seven years later. The first edition has one hundred and eight tints; the second one hundred and ten. The introduction gives the method by which each colour was prepared. The samples are very small (half-inch square), and pasted ten on a page. The name of the colour is given, and examples of the colour where possible from the animal, vegetable, and mineral kingdoms. Thus: *Wine yellow;* body of silk moth; stamina of honeysuckle; pale Brazilian topaz. Most of the colours have by this time considerably altered, and, on comparing the two editions, it is seen that many of the colours, with the same names, are quite different. This scheme met with some success, and was used in Barton's "Flora of North America," 1821.

In 1815 Mirbel, in his "Élémens de Botanique," gave a chart of eighty-three tints, the only explanation given being a näive statement that by its aid any colour whatever can be matched; a statement which appears particularly ridiculous now that all the whites have turned black.

Another scheme which may be mentioned is that of Haytor, which is appended to Sinclair's "Hortus Ericaeus Woburnensis," 1825, one of the well-known Woburn mono-

graphs. An account of the origin of the scheme is given in a letter by Haytor to the Duke of Bedford. Sinclair had "lamented much that no work existed to render clear and definite all communications on the subject of any new or rare bloom. . . . In attempting at present to describe the colour of any given flower, the term *red*, he remarked, was applied to so many blossoms that it was impossible to define precisely what was meant by it; and, to give me an evidence of the want he complained of, he took me to several flowers, generally called *red*, but varying so much that, to my eye as a painter, they each demanded a different appellation for their colour." He adds that matters are made worse by adding the termination *-ish* and arriving at such indefinite but common terms as "reddish" and "greenish." A comparison of the colour descriptions of the same varieties in present-day florists' catalogues shows clearly that matters are quite as bad as a hundred years ago; and the entomologist's *testaceus* and the mycologist's *ferrugineus* show that Latin terms are used with just as much levity. In Haytor's scheme two hundred and seventy-two tints are arranged in a circle in the form of a mariner's compass, and the nomenclature is also nautical, *e.g.*, red, red by purple. Two gradations are appended, one showing the range from black to white, the other from brown to white. The scheme does not appear to have been at all successful.

Another arrangement of general application is that of Hay, "A Nomenclature of Colours applicable to the Arts and Natural Sciences, to Manufacturers, and other purposes of General Utility," 1845. The second edition has forty plates, each with six one and a half-inch-sided triangles of colour pasted in. The samples were very evenly painted, and very little fading appears to have taken place. The introduction gives the author's theories of colour, and the arrangement, which is difficult to follow, is based upon these. The nomenclature, in which "tempered green hue" and such like appear, was also probably a factor against any general adoption by naturalists.

Before this time Chevreul, Directeur des Teintures à la Manufacture Nationale des Gobelins—the national manufactory of tapestry in Paris—began to devise a classification of colours. His first discussion, "La Loi du Contraste simultané des Couleurs," appeared in 1839. A full account of his scheme, and its application, is given in a memoir of nine hundred and forty-four pages (*Mem. Acad. Sci.*, Paris, 1861, "Exposé d'un Moyen de définir et de nommer les Couleurs"). This method, which it would take too long to describe, is still used at the national manufactory of tapestry, and is the basis of the modern French colour schemes. Theoretically, over fourteen thousand different colours, tones, shades, and tints are obtain-

able, but in practice a much smaller number suffices. In 1855 Digeon published a set of ten charts, "Cercles Chromatiques de M. E. Chevreul." The circles are divided into seventy-two sectors, and there is a gradual gradation from red through orange red to orange, and so on. The charts have different percentages of black added, from ·1 to ·9. Thus there are seven hundred and twenty different shades. The name of the colour is denoted by giving the number of the chart and of the sector. Chevreul's full scheme is made more complete by having different intensities of colour.

Radde's "Internationale Farben Skala," 1877, consists of fifteen cards. The first gives the forty-two cardinal tones of the arrangement; the remainder give the range of these from *a* to *v*, thus comprising about eight hundred tints. A sliding block permits of the isolation of adjoining colours. The cards are inconvenient to use: the colours are printed on inferior paper, and are without names. The scheme has been used by mineralogists.

Since this date many different colour schemes have appeared, some of which have been drawn up without any reference to previous attempts, and have repeated faults which otherwise might have been guarded against. In 1886 appeared the book which has been most used until recent years, Ridgway's "A Nomenclature of Colors for Naturalists, and Compendium of Useful Knowledge for Ornithologists." Two of Ridgway's statements are much to the point. "Popular and even technical natural history demands a nomenclature which shall give a standard for the numerous hues, tints, and shades which are currently adopted, and now form part of the language of descriptive natural history." Again: "Popular nomenclature of colors has of late years, especially since the introduction of aniline dyes and pigments, become involved in almost chaotic confusion through the coinage of a multitude of new names, many of them synonymous, and still more of them vague or variable in their meaning. These new names are far too numerous to be of any practical utility, even were each one identifiable with a particular fixed tint." In this book there are one hundred and eighty-six named colours painted into rectangles 1-inch × ½-inch. The colours in the copies of this book which I have examined are not nearly so even as in Hay's book, or in the more recent works. Passing on we come to Saccardo's "Chromotaxia" of fifty samples, with a polyglot nomenclature. This appeared in 1891. In this year also a series of forty colours was given in Costantin and Dufour's "Nouvelle Flore des Champignons," to illustrate the terms used in the descriptions and the symbols in the drawings of fungi.

"A Chart of Correct Colors of Flowers" appeared in *The American Florist* for 1895. This was arranged by Matthews, and consisted of a single sheet with thirty-six squares of colour, with a very simple nomenclature.

Another American horticultural chart appeared about 1900 with the title, "Color Guide for Florists." This was arranged by Kohn, and contains one hundred and forty colour shades. A scheme which has been used by some naturalists is "The Prang Standard of Color." This contains one thousand one hundred and fifty-two examples, and is remarkable for its cheapness, costing only fifty cents. Unfortunately the colours are not named.

The "Répertoire de Couleurs"* of Oberthür and Dauthenay, published by the French Chrysanthemum Society in 1905, contains over one thousand four hundred samples. The colours are named in almost every case in several languages. The great objection to this work is its size.

The "Code des Couleurs"* of Klincksieck and Valette appeared in 1908. It is a convenient little book, containing seven hundred and twenty specimens of colour, but they are merely numbered. The work was prepared principally for the use of mycologists. Both the Répertoire and the Code are arranged on a simplification of Chevreul's method.

Ridgway's "Color Standards and Color Nomenclature"* was issued in 1912. The one thousand one hundred and fifteen samples are named, though some of the names are not such that would appear suitable for a standard nomenclature.

Added to these numerous charts are those of different manufacturers and those drawn up by artists, and so on. Even philatelists have their colour schemes.

Lovibund's tintometer is far too complicated and too expensive for ordinary use in the description of specimens.

The fact that so many attempts have been made to draw up colour schemes shows clearly that a standard of colours is necessary, as is also a standard of nomenclature. Naturalists could decide to adopt the French Chrysanthemum Book or Ridgway. The former was adopted by the Royal Horticultural Society, but recently it has been somewhat ousted amongst horticulturists by the American book, principally owing to the latter being much more convenient to use. On enquiry I find that amongst naturalists these two works are the most frequently used.†

But the Chrysanthemum Book costs a guinea and Ridgway thirty-five shillings. In most branches of science colour is not

* Copies of these works were shewn at the meeting.

† The "Code des Couleurs," though very convenient to use, suffers from the fact that the colours are *unnamed*.

regarded with so much favour as to demand such an outlay, even for a satisfactory range of tints. Colour in many organisms varies so greatly under different conditions that it is not regarded as a specific character. What seems to be required is, not a scale to record the minutest variation, but merely one that will add definiteness to the description of the general range in colour. Probably a scale with about two hundred samples would be found sufficient for ordinary use. In such branches of science as horticulture, mycology, ornithology, and so on, where colour is of more importance, additional colours could be interpolated. If anyone interested in any particular science will look through the colour charts which are here, he will find very many colours which will seem more or less useless in that science, and in certain cases will find that there are not sufficient of certain grades. As an example of what I mean: Horticulturists could dispense with a large number of the colours given in Ridgway; Mycologists certainly can omit page after page. On the other hand, there is already a movement on foot to produce another edition of Ridgway, with more tones, of such colours as "salmon-pink." My own opinion is that it is not wise to attempt to make such a complete range as would satisfy every possible use. The way out of the difficulty is obviously that of having a general scheme with a small number of colours; then additional editions may be provided in those subjects where there is a special demand, or separate sheets of the variations of the original colours of the general scheme could be prepared. If, as one would hope, a standard of colours should be adopted in all branches of science, art, and industry, the latter scheme would appear to be the most feasible. The advantages of having a universal standard of colours are so obvious that one would expect the very great difficulties of obtaining such would not prove insurmountable if the matter be approached in a proper manner.

The earlier schemes lacked one of the primary essentials of colour standards in that they were not standards at all. Ridgway's scheme is the only one in which the colours have been standardised by physical methods, and hence the only one in which the colours can be reproduced with accuracy. In the suggested standard of colours, it would be the work of physicists, by means of such apparatus as Michelin's grating and Maxwell's disc, to give us the definition of our colours. In this way the defect from which all colours suffer to some extent, *i.e.*, fading, could be brought to its lowest terms of inconvenience, though the samples of colour published would be made in such a way that fading would be guarded against as far as modern colour chemistry makes it possible.

The colours in the primary scheme should be named. No sane naturalist wishes to talk in such symbols as "40J8t." On the other hand, the same naturalist would not wish to use many of the colour terms, even in Ridgway, who rightly objects to such absurd names as "ashes of roses" and "elephant's breath." The usual method of assigning colours to common natural objects should be followed, as far as is possible, in the primary scheme. Whether in the more complicated schemes every colour, shade, tint, and hue should receive a name is one for consideration. I am informed that the colours supplied to artists under the same name are not always the same even from the same firm. This is ridiculous, if a colour name means anything. A standard of colours would seem to give some protection.

Unfortunately, most of us suffer from the fact that we have received no colour education. This has probably been one of the principal reasons why many people have not adopted a colour chart: the constituents of a given colour are not appreciated, and hence the difficulty of matching it. More attention seems to be paid to this subject in America than in this country, judging from the literature on the subject.

A further point is that a colour standard should be cheap. Charts of colour samples are supplied gratis by every dealer in artists' colours, wall distempers, and so on; yet the naturalist has to expend a considerable sum for a scheme, eighty per cent. of which is probably useless to him,—and other workers in his subject may be using other charts. There seems no apparent reason why a suitable series of standard colours should not be published at a shilling or so. There is no need for much letterpress dealing with the theory of colour, but a few notes on the best way of comparing colours, having regard to texture of surface and various optical illusions. To summarise:—

1. For ordinary use there should not be too many colours.
2. A fair-sized, even sample of colour should be given.
3. The colour must be as durable as can be obtained.
4. The colour must be standardised by modern physical and chemical methods.
5. Colours to be interpolated in the special cases where necessary.
6. The colours must be named in the primary list, popular names being used where possible, and common objects referred to when suitable. If an international scheme be adopted, there would necessarily be a polyglot nomenclature.
7. The standard must be cheap, well arranged, and in book form.

In conclusion I would express my thanks to the numerous naturalists with whom I have discussed the question of a colour standard.

Since reading the above paper I have received many communications concerning the subject discussed therein. Mr. B. B. Woodward, of the British Museum (Natural History) has called my attention to a "Bird Color Chart" in the first volume of American Ornithology (1901). There are twenty named samples of colour given, but they are very crudely printed. Professor G. S. Boulger has pointed out to me the fact that Bonnier has several references to the "chromomètre de la Société sthénochromique." The first reference appears to be in his study of the variation in the colour of a flower in relation to altitude (Bull. Soc. Bot. Fr. XXVII. (1883)) where on page 104 he writes: "La coloration est assez facile à mesurer en général avec le chromomètre de la Société sthénochromique. . . . Grâce au chromomètre et à la comparaison des couleurs reproduites, on peut reconnaître des variations qu'il est impossible d'observer au premier coup d'œil." I know nothing further of this chromometer at present. It is interesting to note that Herbert Spencer was at one time (c. 1846) interested in the nomenclature of colours. In his Autobiography (p. 309 (1904)), after talking of designs, he writes: "I mention it here chiefly for the purpose of introducing an accompanying thought, respecting the nomenclature of colours. The carrying out of such a scheme would be facilitated by some mode of specifying varieties of tints with definiteness; and my notion was that this might be done by naming them in a manner analogous to that in which the points of the compass are named. The sub-divisions coming in regular order when 'boxing the compass,' as it is called, run thus: North, north by east, north-north-east, north-east by north, north-east; north-east by east, east-north-east, east by north, east. Applying this method to colours, there would result a series standing thus: Red, red by blue, red-red-blue, red blue by red, red-blue (purple); red-blue by blue, blue-red-blue, blue by red, blue. And in like manner would be distinguished the intermediate colours between blue and yellow and those between yellow and red. Twenty-four gradations of colour in the whole circle would thus have names; as is shown by a diagram I have preserved. Where greater nicety was desirable, the sailor's method of specifying a half-point might be utilized—as red-red-blue, half-blue; signifying the intermediate tint between red-red-blue and red-blue by red. Of course these names would be names of pure colours only—the primaries and their mixtures with one another; but the method might be expanded

by the use of numbers to each: 1, 2, 3, signifying proportions of added neutral tint, subduing the colour, so as to produce gradations of impurity.

Some such nomenclature would, I think, be of much service. At present, by shopmen and ladies, the names of colours are used in a chaotic manner—violet, for instance, being spoken of by them as purple, and other names being grossly misapplied. As matters stand there is really no mode of making known in words, with anything like exactness, a colour required; and hence many impediments to transactions and many errors. In general life, too, people labour under an inability to convey true colour-conceptions of things they are describing. The system indicated would enable them to do this, were they, in the course of education, practised in the distinguishing and naming of colours. If, by drawing, there should be discipline of the eye in matters of form, so there should be an accompanying discipline of the eye in matters of colour." Thus Spencer's scheme would be that previously put forward by Haytor with certain refinements afterwards adopted by Chevreul.

In the list of colour charts no reference has been made to those containing less than twenty colours.

RECENT PUBLISHED RESULTS ON THE CYTOLOGY OF FUNGUS REPRODUCTION (1915).

By J. Ramsbottom, M.A., F.L.S.

The science of Mycology has suffered during the past year, as have most other sciences, from the fact that many workers have been following other interests. A number of papers which have been published recently are obviously records of work done previous to the present period of Sturm und Drang. There is difficulty in obtaining certain foreign botanical publications, and it is therefore probable that some cytological work on fungus reproduction has been omitted from the present *résumé*. This the writer hopes to include in the next paper of this series.

PHYCOMYCETES.

ENTOMOPHTHORINEAE.

Majmone (1914) investigated a new species of *Empusa*, *E. elegans* found on the dead larvae of *Porthesia chrysorrhoea*. *Empusa* was one of the first fungi in which nuclei were recorded, Maupas (1879) stating that a large number of small nuclei occurred in *E. Muscae*. Vuillemin (1887) found in a new species, *E. gloeospora*, that there were relatively large nuclei regularly spaced in the hyphae, a single nucleus migrating without division into each conidium. Cavara (1899) contrasted the multinucleate condition of the conidia of *Empusa Muscae* with that of the uninucleate conidia of *Entomophthora Delpiniana*. Olive (1906) investigated six species of *Empusa*, but particularly *E. Sciarae* n. sp. He found in this species, as well as in *E. americana*, *E. Aphidis* and *Empusa* sp. there was a septate conidiophore resulting in a branching growth (i.e., *Entomophthora* auct.) and that the conidia were uninucleate. In *E. Culicis* with a simple conidiophore the septate conidium was normally bi-, rarely trinucleate, and in *E. Muscae* there was an indefinite number of nuclei, frequently about fifteen to eighteen. Riddle (1907) found that the nuclei of the conidiophore of *E. Grylli* were very numerous and irregularly spaced, and that from twelve to fifteen nuclei pass into the conidium, those remaining in the conidiophore after the conidial discharge degenerating. He found in various species of *Entomophthora* that the conidia are uninucleate.

The third genus of the Entomophthorineae which has been studied cytologically is *Basidiobolus* (Eidam (1886), Chmielewski (1888), Raciborski (1896), Fairchild (1897), R. E. Fries (1899), Loewenthal (1903), Woycicky (1904)). The summary given by Riddle of the characters of the three genera is as follows:—

Empusa. Hyphae breaking into hyphal bodies with numerous small nuclei irregularly distributed. Non-sexual reproduction by a multi-nucleate "conidium" which is morphologically a coenocytic sporangium. Apogamy constant.

Entomophthora. Hyphae either breaking into hyphal bodies after passing through a septate condition or else permanently septate, with a few large nuclei regularly spaced. Tendency toward nuclear reduction extended to the non-sexual reproduction resulting in a uninucleate coenosporangium. Resting spores formed by the fusion of primitive coenogametes with few nuclei. Apogamy occasional.

Basidiobolus. Hyphae septate, breaking into hyphal bodies only under abnormal conditions, with a single nucleus in each

cell. Non-sexual reproduction as in *Entomophthora*. Resting spores formed by the fusion of coenogametes of a specialized type, which through the extension of the tendency to nuclear reduction have become uninucleate. Apogamy absent.

Majmone finds that the larvae of *Porthesia*, though externally unaltered, are filled almost entirely with the hyphae of *Empusa elegans*. Hyphal bodies are found scattered about in large numbers within the larval tissues. These free cells are of three principal forms, though intermediate shapes occur. The first form is spherical, appearing, to begin with, somewhat angular, and is very numerous in the tissues and internal lacunae of the larva. The second form is barrel-shaped and usually appears between the spherical cells. Both possess many irregularly distributed nuclei and a thick strongly refractive wall. The third form is elongated and represents the true mycelial hyphae, and the nuclei which are arranged in a row are usually elongated transversely to the direction of the hyphae. The conidiophores arise from hyphal cells which accumulate under the chitinous envelope to form a thick layer. They swell at the apex into a club: numerous vacuoles arise in their protoplasm, the largest of which usually lies about the middle of the club and remains in the conidium when it is formed. These single club-shaped conidiophores are constantly multinucleate and of varying size. They force their way through the envelope and the conidia are then slung off with great force. The conidia are typically pear-shaped, with a large central vacuole, though there are often several small vacuoles also present, and in "verschiedener Anzahl um die Hauptvakuole kranzförmig geordnete Kerne" are to be observed. Conidia are only formed where the envelope is bursted and never within the larval body. The chlamydospores are usually spherical cells with a strongly thickened two-layered wall. The protoplasm seldom occupies the whole of the cell cavity, but is shrunk together and often clings to the inner surface of the endospore. The nuclei, fifteen to twenty in number, are irregularly distributed; the peripheral ones are elongate, while the inner ones are more spherical. Sometimes the protoplasm appears constricted into a crescent-shaped mass, with no apparent nuclei but rich in chromatophilous granules. "Wo Dauersporen auftreten, trifft man nur wenige kugel- und tonnenförmige Hyphenkörper, keine Schlauchzelle, Konidienträger und Konidien; auch die peripherischen Gewebe sind in diesem Falle durch Dauersporen, anstatt von Konidienträgern und Mycelschläuchen, völlig verstopft." "Alle von mir beobachteten Vermehrungsformen von *Empusa elegans* scheinen asexuellen Ursprung zu haben." Within the organs of the host are also found

irregular, weakly staining large plasma masses with very thin walls, and finely granulate contents rich in chromatophilous granules of different sizes.

The nuclei of the hyphal bodies take up stains so strongly and regularly that it is practically impossible to study their finer structure, and in no case was true nuclear division seen. During the budding of the hyphal bodies the nuclei wander to the periphery and the wall projects in one portion forming a swelling which finally breaks open at the tip. A portion of the protoplasm now flows out through the opening and surrounds itself with a thin wall. The daughter cell grows, nips itself off from the mother cell, and assumes a spherical shape. No nuclear division takes place.

The chlamydospores arise from the spherical hyphal bodies. The protoplasm of the latter becomes rich in chromatin granules while the nuclei gradually disappear. The cell now becomes perfectly spherical in form, the wall thickens, the granules gradually disappear, and nuclei can again be observed. (This close relation between chromatin granules and nuclei is common in Protista.*) The exosporium and endosporium then become differentiated. The description given of the formation of "azygospores" differs from that given by Riddle for *E. Grylli*, where the hyphal body is stated to swell out as a protuberance into which protoplasm and nuclei pass: the protuberance continues to expand until it forms a rounded ampulla. The protoplasm and nuclei pass in and a cross wall is formed. No nuclear division is recorded either by Riddle or by Majmone, though this has been observed by Cavara in *Entomophthora Delpiniana*, and both division and fusion by Vuillemin in *E. gloeospora*.

PROTOMYCETACEAE.

Büren (1915) has written an account of the Protomycetaceae of Switzerland, and includes the details of his cytological and biological researches of which he has published preliminary notices.†

Protomyces macrosporus lives on different Umbelliferae, and its development is known from the work of de Bary (1864) and Popta (1899). The membrane of the resting spore is three layered, consisting of a very thick, colourless, unsculptured epispore and a very thin mesospore, and endospore. The spore contents in the resting stage appear thick, finely granular and somewhat turbid. After a winter rest the spore germinates. The contents differentiate into a peripheral layer, which

* *Cf.* also *Polyphagus Euglenae*, Trans. Brit. Mycol. Soc. IV., p. 252 (1913).

† *Cf.* Trans. Brit. Mycol. Soc. IV., p. 91 (1915).

appears light, and a central portion darker in appearance. (Popta believed this different appearance to be due to the absence of fat from the external layer, and its presence in the interior.) By degrees vacuoles appear in the denser central portion. They gradually extend into the periphery so that the whole contents have a honeycomb-like appearance, and the differentiation between the two portions is lost. The wall of the resting spore now ruptures and the sporangium projects as a spherical vesicle having the endospore as its wall. The many vacuoles now begin to fuse until finally there is only one large central vacuole leaving the protoplasm as a broad, vacuolate, peripheral layer, which gradually becomes homogeneous in appearance. Radial streaks vertical to the sporangial wall begin to arise in this layer until finally it appears divided into regularly polygonal portions. The streaking then begins to fade away "und aus dem Plasma differenzieren sich grobe Körner heraus, deren Conturen immer schärfer hervortreten." These are the spores which are elongate-elliptical in shape and show a swarming movement. (Popta's account differs somewhat. She states that in the homogeneous peripheral layer a fine network appears, of which the meshes become thicker and differentiate separate bodies which fall apart and represent the beginnings of spores which according to her figures lie in two or three layers.) The young spores lie quite irregularly on the sporangium wall and do not pass into the central vacuole, thus indicating the presence of a membrane, which, however, escaped observation both in living and in fixed material. The further stages are somewhat complicated and the author is not very certain as to them. From the spore mass, small vacuoles pass out which collect between it and the wall, and at the same time the central vacuole becomes smaller. A thin protoplasmic layer, which has not entered into spore formation, lies closely applied to the wall. Plasmatic septa separating the vacuoles join up this layer to the spores, and these arched septa "scheinen mir mit dem oben erwähnten Plasmastreifen in engster Beziehung zu stehen. Diese Plasmaplatten rühren offenbar davon her, dass bei der Bildung der Sporen ein Teil des Plasmas unverbraucht geblieben ist." The spores now become massed in a dense ball at the apex of the sporangium and the plasmatic plates rapidly disappear. The sporangium wall then ruptures and the spore mass is violently ejected. "Bewegungsorgane fehlen den Sporen ganz, dem entsprechend auch eine aktive Ortsveränderung. . . . . Unmittlebar nachdem die Sporen aus dem Sporangium ausgeworfen worden sind, sieht man, dass sie sich paarweise verbinden. Nachdem sie kleine Fortsätze gegeneinander ausgestülpt haben, kopulieren sie miteinender." The spores

are capable of germination on filter paper moistened with nutrient solution: they bud somewhat in a yeast-like manner, though the individual cells do not separate. When a spore is placed on the host plant it sends out a germ tube which penetrates between the epidermal cells and branches profusely in the intercellular spaces of the parenchyma. The mycelium is septate, and though small lateral branches are found here and there, no haustoria are produced. Certain portions of the hyphae swell and form small chlamydospores (resting spores) which quickly increase in size.

With regard to the cytological features: The nuclei in *P. macrosporus* are by no means well differentiated. "Es sind nur Chromatinkörper von allerdings ziemlich regelmässiger Gestalt." Neither nucleolus, nuclear cavity nor even chromatin could be differentiated even in well fixed and stained preparations. The resting spore contains a rather dense protoplasm with many equally distributed nuclei. The central portion stains deeply. The various stages observed in fresh material show up much more clearly in fixed and stained material. The radial streaks which arise when the protoplasm has become confined to a peripheral layer appear as gaps, and the separate portions of protoplasm give the idea of naked cells. Each of these portions standing perpendicularly to the sporangium wall contains a single nucleus. "So gelang es mir einmal, in einem Präparat den Kern in den eben beschriebenen Portionen in Teilung zu finden." The nuclear spindle was somewhat obliquely orientated. Later the segments of protoplasm divided into four (but apparently not by simultaneous divisions) and thus give rise to spores. The author regards the naked cells, therefore, as spore mother cells, and the divisions he supposes to be reduction divisions. The spores are uninucleate, but after they are shed they show two or three refractive bodies which take up the stain. Büren considers these to be metachromatic granules: they often arrange themselves around the periphery of the vacuoli in germinating spores. In fusion "ein Uebertritt dieser Körper durch die Querbrücke konnte auch an den fixierten Präparaten nicht beobachtet werden." The young mycelium is multinucleate. Unfortunately the nuclei are very small and do not allow of clear differentiation. The author believes, however, "dass sie eigentliche Kerne sind, welche mit metachromatischen Körpern nichts zu tun haben. Eine Kernverschmelzung war aber im Mycel nicht zu finden." The young chlamydospores are at first multinucleate with the nuclei regularly arranged. "In etwas älteren Chlamydosporen habe ich aber zu wiederholten Malen solche Bilder angetroffen, die auf eine Kernpaarung hinweisen. . . . Die Kerne zeigen deutlich eine paarige Annä-

herung. . . . Demnach würde also die Kernpaarbildung besz. Kernverschmelzung im Entwicklungsgang hinausgeschoben, indem sie nicht bei der Sporenfusion, sondern erst in der jungen Chlamydospore stattfindet." Some figures were doubtfully those of division which must, of course, take place in the chlamydospore. Owing to the small size of the nuclei it was impossible to be sure of the facts.

A second species of *Protomyces*, *P. pachydermus* (parasitic on *Taraxacum officinale*) was similarly studied. Brefeld and von Tavel (1891) have described spore formation in this species. During germination the protoplasm of the central portion of the resting spore becomes denser, but after some time the whole of the protoplasm becomes homogeneous and remains so up to the period when the endospore projects as a cylindrical sporangium. Then vacuoles begin to appear at its base and flow together so that finally there is a large central vacuole and the protoplasm lines the wall of the sporangium. The nuclei in this species are much larger and clearer than in *P. macrosporus*. "Man kann deutlich einen Nucleolus und eine Kernhöhle unterscheiden. Chromatin kann allerdings kaum wahrgenommen werden." The protoplasm of the resting chlamydospore has a net-like structure with numerous nuclei regularly distributed in it. As the sporangium is emerging, the protoplasm of the lower portion within the spore becomes coarser while the nuclei pass into the upper portion. Later the nuclei appear somewhat smaller and their number greater, indicating that nuclear divisions have taken place. The formation of "spore mother cells" takes place as in *P. macrosporus*. Each of these cells is at first uninucleate, but in tangential sections two, three, and four nuclei were often observed. "Es is mir leider niemals gelungen, Teilungsbilder des primären Kerns zu beobachten, auch habe ich nie Stadien gesehen, die eine Aufteilung der 4 kernigen Zellen in 4 einkernige Zellen gezeigt hätten. Ich glaube aber dessenungeachtet mit Sicherheit annehmen zu dürfen, dass auch hier die Sporen in derselben Weise angelegt werden, wie ich es für *P. macrosporus* nachweisen konnte. Dafür spricht schon der Umstand, dass die Sporen etwa viermal kleiner sind als die Plasmaportionen." The ripe spores are uninucleate. Copulation takes place as in *P. macrosporus*. The mycelial cells are multinucleate. In the young sporangia what is apparently nuclear pairing occurs, but there is the same doubt as in the former species.

Protomyces kreuthensis and *P. Crepidis* (n. sp.) "in ihrem Entwicklungsgang vollständig demjenigen von *P. pachydermus* anschliessen," the only difference being in the distribution of the chlamydospores in the host tissues.

The author also investigated *Protomycopsis*, which differs from *Protomyces* in the fact that the chlamydospores are terminal and not intercalary. The mycelium and resting spores of *P. Leucanthemi* are found principally in the spongy parenchyma of the leaf. The wall of the spore appears in section as if it were built of small rods (cf. *Elaphomyces cervinus* and also aecidiospores). The description of spore formation as made out from fresh material appears to agree in all respects with that of *Protomyces pachydermus*. When the spores are ejected from the sporangium, however, they do not copulate.

In the resting chlamydospore the numerous nuclei are evenly distributed: they show a clearly differentiated nucleolus and nuclear cavity. After the sporangium has projected, the nuclei appear smaller and in greater number, showing that nuclear division has taken place. Vacuolisation of the protoplasm begins in the portion of the sporangium enclosed within the resting spore. "Im Wandbelag sind die Kerne relativ gut zu sehen." Division of the protoplasm of this layer occurs as in the previous species. "In einigen meiner Präparate sah man Kerne dieser Portionen, die Teilungen erfahren halten." Two and three nuclei were seen, but never clearly four, though Büren holds that it is exceedingly probable that in a later stage four nuclei are present and that the segments divide then into four uninucleate spores. In the spores the refractive granules which the author interprets as metachromatic bodies are present. A thin layer of protoplasm, which does not enter into spore formation, can often be distinguished closely adpressed to the wall of the sporangium. "Ueber die cytologischen Verhältnisse des Mycels konnte leider noch nichts in Erfahrung gebracht werden."

Protomycopsis Bellidis was also investigated: it agrees with *P. Leucanthemi* in spore formation as seen in fresh material, the account given differing a little from that of Popta; no cytological details are given. Thus, in addition to the place of origin of the resting spore, *Protomycopsis* differs from *Protomyces* in the structure of the spore wall as well as in the fact that there is no conjugation of spores.

Büren also studied *Taphridium rhaeticum*, which infects *Crepis* spp. The spores of this species copulate in pairs on becoming free from the sporangium. They bud freely in nutrient solutions in the same manner as *Protomyces*. They also contain similar metachromatic granules. The youngest stage found of the chlamydospore showed a protoplasm of fine network structure with evenly distributed nuclei. Later the nuclei appear appreciably larger and show traces of chromatin. In a further stage small nuclei with a scarcely

visible nucleolus are seen surrounded by a membrane. These small nuclei are obviously the result of one or more divisions after which free cell formation has taken place. The cytoplasm has at this time a filiform structure. The appearance is very similar to that figured by Juel (1908) for *Taphridium umbelliferarum*, though Büren in his control preparations of this species did not find free cells. The question arises whether these cells are to be regarded as directly forming spores or as spore mother cells. Juel was unable to decide, though he inclined to the latter view. Büren's material was not sufficient to enable him to settle the question. In the next stage found, the uninucleate spores are more or less mature within the sporangium, and then pass into the protruded endospore, as in *T. umbelliferarum.* "Es darf aber doch mit Sicherheit behauptet werden, dass *Taphridium rhaeticum* Volkart sich in seiner Entwicklung an *Taphridium umbelliferarum* anschliesst, nicht nur, weil das Endosporium hier anstritt, sondern weil sich auch die cytologischen Verhältnisse stark an die letzgennante Gattung und Spezies anlehnen, was die Sporenbildung anlangt." The genus *Volkartia* is therefore emended to include both species. *Taphridium algeriense*, where the cells which are to form spores have a peripheral situation (Juel 1908) is placed with "*Protomyces inundatus*" in which a similar arrangement has been described by Sappin-Trouffy (1897) and Dangeard (1903), in the genus *Taphridium*, which is also emended. When it is remarked that the species first named *Taphrina umbelliferarum* now enters into its fourth genus, it will be seen that the nomenclature of the group is in a most unsatisfactory condition.

The systematic position of the Protomycetaceae is a matter of debate. De Bary (1864) on his first study of the genus *Protomyces* placed it in the Ascomycetes, but later (1887) considered its position to be between the *Chytridiaceae* and the *Ustilagineae.* Brefeld (1891) finally placed *Protomyces*, *Ascoidea* and *Thelebolus* in a group formed for their reception, the Hemiasci. Dangeard (1903) also placed *Protomyces* in this intermediate class. The researches of Popta, however, showed that the genus could not be regarded as a connecting link between Phycomycetes and Ascomycetes, and she inclined more to the idea of uniting it to the former. The point at issue is whether the vesicle arising from the resting spore is to be regarded as a sporangium or as an ascus. Büren holds that in all probability nuclear fusion takes place in the young chlamydospore, and that reduction occurs in the two divisions giving rise to the spores. He, therefore, regards the spore mother cells as comparable with asci, and the whole vesicle as a synascus, and suggests that the nearest relative is *Dipo-*

dascus. The reasoning is obviously very open to criticism, as it has not been made out clearly where the two nuclei which are supposed to fuse become associated. If they become paired in the copulating spores and fuse in the young resting spores, there is an exceedingly interesting resemblance to what takes place in certain Ustilagineae. The position of the Protomycetaceae in the natural system cannot be yet considered settled.

ASCOMYCETES.

DISCOMYCETES.

Much attention has been given to *Pyronema confluens* both from a morphological and a cytological standpoint.* In a preliminary note, Brown (1908) mentioned a form in which the trichogyne did not fuse with the antheridium, and now (1915) publishes his full account. "This character and several minor ones seem, however, to distinguish it quite sharply from the ordinary form, and so it has been thought better to give it a varietal name. The one selected [*inigneum*] has reference to the conditions under which it grows." Kilhmann (1883) found his material in clefts of stones and obtained successive crops by watering the stones every three or four days. Harper (1900) obtained his material on half-charred masses of leaves and also amongst damp, well decayed leaves which had not been burnt. He found the fungus unable to withstand the dryness of the laboratory air for even a few hours. Kesaroff (1908) and Seaver (1909) found that *Pyronema* grew abundantly on soil sterilized by heat but not on unsterilized soil.† Seaver found that his strain always produced abundant crops on soil or leaf mould which had been sterilized by heating to high temperatures or by steam heat if under sufficient pressure, while he was never able to produce more than a beginning of growth on unsterilized soil. Brown found that his variety grew very vigorously on the outside of clay flower pots which stood in an ordinary laboratory where the air frequently became quite dry. "The differences in the conditions of sterilization and moisture under which the strains, described by Harper, Kihlman, and Seaver, were grown would seem to indicate that in *Pyronema* . . . there may be different physiological varieties which are entirely similar morphologically."

Seaver's strain was used throughout the investigation for comparison. The ascogonia of the var. *inigneum* are usually

* *Cf.* Trans. Brit. Mycol. Soc., p. 140 (1913).

† Claussen (1912) also obtained his material from sterilized soil. *Cf.* also Presidential Address, Trans. Brit. Mycol. Soc., Vol. I., pp. 132-3 (1900).

produced in rosettes of from fifteen to twenty. The ascogonia are large oval cells and each is supported by a stalk consisting of several cells which are smaller than the ascogonia but larger than the other vegetative cells. All the cells are multinucleate. A long, slender, single-celled trichogyne is produced on the upper surface of each ascogonium. The trichogyne lacks the beak or snout-like projection at its apex found in the normal form. "In the variety *inigneum*, the antheridia and ascogonia are much more independent of each other than in the normal form. Frequently an ascogonium and the antheridium connected with its stalk are so far apart that even if the trichogyne grew straight towards the antheridium its length would not be anything like great enough to connect the two. The growth of the trichogyne appears, moreover, to be quite independent of that of the antheridium. Frequently the trichogyne grew straight out in an opposite direction from that in which the antheridium developed." Sometimes a trichogyne coiled itself round an antheridium, sometimes two trichogynes coiled round one antheridium. In only a few cases, however, did the trichogyne grow over the antheridium or direct its tip against the tip of the latter. "In no case was the fusion between trichogyne and antheridium observed. . . . In sections the ascogonia, trichogyne and antheridia of the variety *inigneum* retain their normal form long after the ascogenous hyphae have grown from the ascogonia." After an ascogonium has attained its mature size the nuclei in the trichogyne degenerate as in the normal form. In the process the nucleoli enlarge while the nucleus swells up and the rest of its contents become transparent. The nucleoli are usually apparent for a short time after the nuclei go to pieces, while the remains of the nuclei produce a mesh-like appearance in the cytoplasm. The antheridia retain their normal appearance long after the formation of the ascogenous hyphae and sometimes even after the appearance of the first asci. After a time, however, their nuclei degenerate, the antheridia become vacuolate and their contents degenerate. (In the normal form vacuoles appear in the antheridium after the nuclei have migrated into the trichogyne and at an earlier stage than in the present form.) The development of the ascogenous hyphae agrees with Harper's description. "The nuclei from the ascogonium migrate into these hyphae in an irregular manner and not in pairs as described by Claussen. This early pairing of nuclei would not be expected in the variety *inigneum* for Claussen believes that each pair is composed of a nucleus derived from the ascogonium and one from the antheridium." A considerable proportion of the nuclei in the ascogonia never migrate into the ascogenous hyphae, but degenerate *in situ*.

No fusion of nuclei, except of degenerating ones, was observed in the ascogonia or ascogenous hyphae, the only one observed being the usual one in the ascus. There were, however, appearances resembling fusing nuclei. "When the nucleus is preparing for division and is consequently large, the spireme or chromosomes frequently contract into a rather dense mass resembling a second nucleolus. The nucleus at this stage might readily be taken for a fusion nucleus. Also just after division, the daughter nuclei may reorganize so close to each other as to be pressed together, and thus look like fusing nuclei." The author described similar appearances in *Lachnea scutellata*.* The asci are formed from hook-shaped hyphae at the tips of the ascogenous hyphae in the usual manner. Two nuclei divide simultaneously into four, which become arranged in a uninucleate ultimate and an antepenultimate cell and a binucleate penultimate cell. The penultimate cell may then produce an ascus or a second hook. The ultimate and antepenultimate cells usually fuse, the nucleus of the latter passing into the former, which may then form another hook, as first described by McCubbin in *Helvella* (1910), and since by Brown (1911) and Claussen (1912). "When a penultimate cell gives rise to an ascus, the two nuclei fuse, after which the fusion nucleus goes into synapsis. After synapsis a spireme emerges which contracts and divides into five chromosomes. These become arranged on the spindle and five daughter chromosomes pass to each pole. In doing so, they do not divide as in *Lachnea* [*scutellata*], but usually become dumb-bell shaped. In the next two divisions giving rise to eight spore nuclei, and in the first division of the spore nucleus, there are also five chromosomes. It thus appears that the same number of chromosomes, five, persists through all the divisions of the life history of the plant."

It must be said that there have been comparatively few detailed studies on the divisions of the ascus nucleus. The outstanding problem in the Ascomycetes is whether a nuclear fusion occurs only in the ascogenous hypha or whether there is also one in the ascogonium or its equivalent, and it would seem that part of the solution is to be found in the nuclear divisions preceding spore formation. The present study is interesting when related up to the investigations of Van Tieghem (1884) and Dangeard (1907). The former found that *Pyronema* is very susceptible to external conditions, and observed forms in which the ascogonium and antheridium were normal, forms in which these organs were reduced in size and forms in which the antheridium was absent, though the ascogonium developed normally. Brown's contention that his

* *Cf.* Trans. Brit. Mycol. Soc. III., p. 357 (1912).

observations agree with what one would expect if Claussen's theory is correct, is open to discussion. One would think it more likely that the female nuclei would associate in pairs, and this is what Ramlow has recorded in the Ascobolaceae (vide infra).

Ramlow (1914) has published an account of his researches on the Ascobolaceae. This family has always attracted morphologists since 1866, when Woronin discovered a scolecite in *Ascophanus pulcherrimus*. The first species to be examined cytologically was *Ascobolus furfuraceus*. In this species, Harper (1896) found that the cells of the archicarp were at first uninucleate, but afterwards became multinucleate, the nuclei passing through pores in the walls into an enlarged central cell. Welsford (1907) confirmed this—Dangeard (1904) had stated that the cells were multinucleate from their initiation—and reported a fusion of nuclei in pairs in the enlarged ascogonial cell. Barker (1903-4) working with a species of *Rhyparobius*, found that the archicarp consists of a small coiled hypha, the ascogonium, and a slender hypha arising from the next cell of the mycelium, which grows over to the tip of the ascogonium, and appears to be an antheridial branch. Both the antheridial branch and the ascogonium are uninucleate when first formed, but subsequent nuclear division occurs in each organ a little before the time of fusion. The fusion takes place near the tip of the ascogonium. The ascogonium consists for a short period of a row of several uninucleate cells, but which are later found in a bi- or occasionally quadri-nucleate condition. The ascogenous hyphae arise from these cells. Ramlow (1906) found in *Thelebolus stercoreus* a coiled ascogonium which was at first uninucleate like the mycelial cells but afterwards became four- and finally eight-nucleate. Septation takes place and the ascogonium is divided into one bi-nucleate and several uninucleate cells. The single ascus arises from the binucleate cell. Dangeard (1907) recorded somewhat similar stages in a fungus which he named *Thelebolus stercoreus*, but which was apparently a species of *Rhyparobius*—according to Ramlow, near to *R. myriosporus*. Dangeard also investigated *R. brunneus* and *R. Cookei*, and recorded similar ascogonia; *Ascobolus glaber* and *A. mirabilis*, which are similar to *A. furfuraceus; Saccobolus violaceus*, in which there is an ascogonium in shape recalling that of *Eurotium*, consisting of long multinucleate cells; and *Ascophanus ochraceus*,* in which he found from eight to fifteen ascogonia

* Dangeard, because of the number of ascogonia which resembles that of *Pyronema* and *Ascodesmis*, removes *Ascophanus* from the Ascobolaceae to the Pyronemaceae. But *A. carneus* has only one ascogonium. The genus may be a transition genus (if *A. ochraceus* is rightly placed there), and we may further have the variations which apparently occur also in *Rhyparobius* and *Thelebolus*.

in each fruit, recalling in shape the ascogonia of *Pyronema confluens*.

Cutting (1909), working with *Ascophanus carneus*, found a single ascogonium with cells apparently multinucleate from their initiation. He records fusion of nuclei in pairs in the ascogonial cells (vide infra).

According to Ramlow the spore of *Ascophanus carneus* germinates on dung agar without difficulty, and the mycelium grows rapidly. The spore was never seen to divide as described by Cutting (1909). The mycelium grows quickly, and quicker in the dark than in full light. The rows of chlamydospores mentioned by previous workers arise under abnormal culture conditions. The development of the ascocarps is favoured by light. Lateral hyphae arise from the vegetative mycelium and quickly roll up in a screw-like manner. When mature, the archicarp is usually composed of seven or eight cells filled with dense, granular protoplasm. Enveloping hyphae arise partly from the basal cell, but principally from the vegetative cells. "Einen Mycelzweig, den man als Antheridialast ansprechen könnte, und einen Vorgang, der sich als Vereinigung zweier Sexualorgane deuten liesse, habe ich nicht beobachtet. Die mittleren Zellen der Schraube haben einen grösseren Durchmesser, im übrigen aber sind alle Zellen des eben beschriebenen normalen Ascogons (Archicarps) gleichartig; von einem 'vegetativen' Teil am oberen Ende kann gar keine Rede sein." In cultures which are not normal, which is soon seen by the frequent appearance of chlamydospore rows, the archicarps are irregular in shape: the upper portion grows out much longer than in normal cases and is very poor in protoplasm, and the archicarp contains more cells: enveloping hyphae also arise from the upper cells of the archicarp: the lower cells of the archicarp are rather poorer in cell contents than those of the middle of the coil. From these results Ramlow criticises Dodge's figures of archicarps, particularly that of "hypha in contact with the trichogyne."* There is no sexual act but the whole appearance is that (possibly on account of defective nourishment) the protoplasm retires into certain cells of the ascogonium for fruit formation just as in the chlamydospore rows, where the uppermost cells, and also sometimes the lower cells, becomes almost or quite empty. Culting says: "Sometimes the archicarp seems to arise in a dense tangle of 'chlamydospore-rows.'" He also differentiates the archicarp into three clearly recognisable regions, "a basal vegetative

* Dodge B. O. Methods of culture and the morphology of the archicarp in certain species of the Ascobolaceae (Bull. Torr. Bot. Club XXXIX., p. 139 1912).

part, a central ascogonial, and a terminal vegetative." Ternetz also described the end of the archicarp as sometimes growing out vegetatively and being able then to form new ascogonia on the projecting vegetative hypha. Ramlow holds that all these are abnormalities. "Meine zahlreichen Beobachtungen zeigen aufs deutlichste, dass dieses 'vegetative Auswachsen' des Ascogons nicht die Norm ist." The further development shows nothing special. The author was unable to establish whether ascogenous hyphae arise from one or several of the ascogenous cells: Cutting found that the latter was the case. Fine hyphae grow out from the young fruit bodies into the air and often lie together in a bunch. Ramlow notes, as everyone must have observed who has grown *Ascophanus carneus* in pure culture, that the colour of the fungus depends upon the dampness of the substratum and upon the amount of illumination.

The spore contains a comparatively large nucleus. When the spore increases in size before germination the contents become vacuolar and the first nuclear division takes place. Further divisions follow rather quickly, but not simultaneously, so that five, six, or more nuclei are present before the germ tube grows out. The nuclei pass into the tube, which is densely filled with protoplasm, while the spore is almost empty of contents. The mycelium grows very quickly, the nuclei divide, and septa are formed. The number of nuclei in the cells varies from three to seven. The ascogonium at its initiation is multinucleate. The nuclei multiply rapidly, and in the completely developed ascogonium their number is very great, "und man wird nicht zu hoch greifen, wenn man die Zahl der Kerne im Ascogon, ehe es die ascogenen Hyphen entsendet, mit 200-250 angibt." The nuclei are not all of the same size, so that in some cells, especially in the larger central cells of the ascogonium, bigger nuclei are present. The nuclei reach their full size first in the central cells of the ascogonium. The well-known openings in the septa of the ascogonia are present and allow of the passage of protoplasm and nuclei from one cell to another. "Die linsenförmigen Körper, die häufig in der Mitte der Querwände auftreten, habe ich nur in den oberen Zellen, jedenfalls nie zwischen den Zellen des Ascogons gefunden, in denen die Kerne am weitesten entwickelt sind." Cutting considered that these granules had the function of dissolving the cell wall and so establishing there the large secondary openings. He observed them in all parts of the archicarp. From the positions in which he found these bodies Ramlow is of the opinion that they are chiefly concerned in closing the pores. The nuclei in the ascogonium have at first no definite arrangement, but later a definite pair-

ing of nuclei can be observed. The nuclei often lie so close together that they flatten at the point of contact, though the membranes remain distinct. According to Cutting, "After this the nuclear membranes, at the point of contact, disappear, giving rise to the characteristic dumb-bell-like structure. After this the nuclear membrane takes on a spherical shape, and inside it are to be seen the two nucleoli of the original fusing nuclei. These nucleoi fuse later, going through a dumb-bell stage just as the fusing nuclei themselves have done. The fusion nucleus is easily recognized, both by its size and by the size of its nucleolus." Such fusions of female nuclei in the ascogonium have been recorded by many workers since Blackman and Fraser (1906) first reported them in *Humaria granulata*. Ramlow, however, does not regard these fusions as normal. "Ich fand in Schnitten durch das Ascogon von *Ascophanus carneus* die gleichen Bilder in grosser Zahl. . . . Aber diese Bilder befriedigten mich nicht, nachdem ich herausgefunden hatte, dass die Fixierung der Kerne durchaus nicht allen Ansprüchen genügte, und im weiteren Verlaufe der Untersuchung habe ich bei besserer Fixierung ein anderes Resultat festgestellt. Eine Kernfusion findet im Ascogon von *Ascophanus carneus* nicht statt." The two nuclei do not fuse, but pass in pairs into the ascogenous hyphae as Claussen describes for *Pyronema confluens*.* "Die in die ascogenen Hyphen wandernden Kerne zeigen hier und schon im Ascogon ausser dem Nucleolus ein deutliches Centrosom, von dem das Chromatin radial ausstrahlt. Dies klare Hervortreten des Centrosoms war mir das beste Criterium für gute Fixierung und Färbung der Kerne." The ascogenous hyphae become septate, each cell containing a pair of nuclei unless it branches out: the lowest cell so long as all the nuclei have not passed from the ascogonium contains several pairs. "Nicht alle Kerne des Ascogons treten in die ascogenen Hyphen, wie auch nicht alle sich zu Paaren ordnen." Those which remain in the ascogonium degenerate; they swell, their contents stain diffusely, lose their spherical shape, and their nucleolus disappears. Two or three often fuse together and form large nuclear vesicles with two or three nucleoli. "Das sind dann die 'Fusionkerne.' Ihr Schicksal ist aber ein ganz anderes als das, was ihnen von den oben angeführten Autoren zugewiesen ist." These fusion nuclei do not pass into the ascogenous hyphae, but disorganize, sometimes leaving only the nucleolus visible. The ascus forms in the normal manner and shows the branchings which have been given special attention by McCubbin (1910), Brown and Claussen. The nuclear divisions

* *Cf.* Trans. Brit. Mycol. Soc. IV., p. 142, 1913.

in the ascus are very difficult to follow, and the author was unable to make a complete study of them: Cutting did not observe these divisions at all. Spore formation follows the usual course.

Working with *Ascobolus immersus* the author was able to grow it in pure culture. Many germination tubes are produced by the spore. The older hyphae are full of coarse grained protoplasm and the walls and septa are thick. The hyphae grow very quickly, especially in the dark. The development of the fruit-bodies, on the other hand, takes place more quickly in the light. The beginnings of the ascogonium appear early as side branches, which have at least the diameter of the main hypha. They are densely filled with protoplasm and soon bend, and with further growth form regular coils of up to seven turns: the end often becomes straight. When no cellulose is given to the fungus, and in the last fruits produced in normal cultures, the upper part of the coil is often empty of contents. "Die normalen Ascogone sind bis oben hin, die abnormen in dem unteren und mittleren Teil dicht mit körnigem Plasma gefüllt, in dem grössere, stark lichtbrechende Körner in grosser Zahl zu beobachten sind." Enveloping vegetative hyphae grow from the basal ascogonial cells, from the main hypha and from neighbouring hyphae. "Wie bei *Ascophanus carneus* ist weder ein Antheridial-Ast zu sehen, noch ist eine Vereinigung von Sexualorganen zu constatieren." The cells of the ascogonium increase rapidly in size. From the envelope extremely delicate septate hyphae of considerable length project into the air and cluster together on the least drying. At the base of the fruit bodies a mass of radial hyphae is present which, as in *Ascodesmis* and *Ascophanus*, serves as a hold-fast and for nourishment.

The ascogenous hyphae arise from a single cell of the ascogonium. The ascus normally contains eight spores, but often only four, five, six, or seven are present: in one case sixteen spore beginnings were seen.

The division of the nucleus during spore germination was not observed. The mycelial cells are multinucleate. The ascogonium from its inception is also multinucleate. The nuclei are comparatively small, though not all of the same size. Development proceeds most rapidly in the middle cell. Before the appearance of ascogenous hyphae the nuclei pair. There are also here appearances of nuclear fusion. "Ich war am Anfang auch der Meinung, dass hier eine Kernfusion vorliegen müsse, bis ich im Laufe der Untersuchung mich überzeugen musste, dass das eine Täuschung als Folge mangelhafter Technik war. Eine Kernfusion tritt im Ascogon von *Ascobolus immersus* nicht auf. Die Kerne treten zu

Paaren zusammen, bleiben als Paare nebeneinander und wandern als Kernpaare in die ascogenen Hyphen, wo sie an Grösse zunehmen." At the conclusion of growth each cell of the ascogenous hyphae contains two nuclei. Here, as in *Ascophanus carneus*, the presence of a centrosome is a sign of good fixation. Nuclear divisions in the ascogenous hyphae were not observed; if they occur it must be very seldom. No branching of ascogenous hyphae was seen, and the absence of this and the fact that certain ascogonial nuclei degenerate accounts for there being few asci produced though the number of nuclei in the ascogonium is large. Ascus formation is normal. The definitive nucleus of the ascus is rather large and the division stages easy to find, though the smallness of the nuclei renders the investigation difficult, but "die Zahl der Chromosomen in allen drei Teilungen die gleiche ist (16)." Spore formation occurs in the usual manner.

Ramlow has also some remarks on *Thelebolus Zukalii*. He states that "die Anlagen typische Doppelschrauben, wie bei *Gymnoascus* oder bei *Boudiéra (Ascodesmis)* sind. Es lässt sich mit grösser Wahrscheinlichkeit die Vermutung aussprechen, dass es sich hier um zwei Sexualorgane handelt. . . . Neben diesen Doppelschrauben habe ich . . . eine Form der Fruchtanlage beobachtet, die an die anormalen Anlagen bei *Ascophanus* erinnerte." He also states "Es ist durchaus möglich, dass in der Gattung *Rhyparobius* noch sexuelle Formen enthalten sind; meine Beobachtungen bei einem 32 sporigen *Rhyparobius (Solms-Laubachii?)*, der sogar fast regelmässige Doppelschrauben—ähnlich denen bei *Ascodesmis*, nur mit weniger Windungen—zeigte, lassen das bestimmt vermuten."

It may be that the work of Ramlow has solved the puzzle of nuclear fusions in the ascogonium, concerning which there has been so much controversy. It must be pointed out, that the investigators who have recorded "trichogynes" have in every case used specimens growing on their natural substrata, and it is difficult to understand how these could be badly nourished as a general rule.

PYRENOMYCETES.

Killian (1915) has published a preliminary account of his investigations on the development of the perithecium of *Venturia inaequalis*, of which the conidial stage is *Fusicladium dendriticum*. During summer the conidial stage is found on the leaves of the apple tree, but in late autumn its growth ceases and when the leaves are shed, the conidial vegetation dies away from the upper surface of the leaf. The vegetative mycelium which previously only occurred under the cuticle without damaging the epidermis, now penetrates the tissues of

the leaf and grows in all directions, particularly in the spongy parenchyma where the initial stages of perithecial development occur. The ascogonium arises as a side branch to a vegetative hypha and rolls itself up in a manner resembling a snail shell, giving in section a figure resembling a Greek σ "Weder der Grösse noch dem Inhalt nach unterscheiden sich diese Zellen von jeder anderen *Venturia*-Hyphe." In older stages the cell contents stain more deeply, the nuclei are larger and the brown membrane appears stretched. The young perithecium increases in size and an outer and an inner portion become differentiated: the former which builds the perithecial wall becomes strongly stretched in length, while the latter, which gives rise to the ascogonial portions, increases greatly in volume and in the number of nuclei. Later the perithecial wall becomes differentiated into a three-layered plectenchymatous structure. The ascogonium is composed mostly of quadrinucleate cells. The central portion enlarges until it finally fills the middle portion of the perithecium. The peripheral cells of the ascogonium, on the other hand, increase in length, particularly the end cell, which finally forces its way through the perithecium. "Diese Zelle nun stellt die Anlage eines Trichogynes dar. An ihr wurden nämlich. . . . Kopulationsvorgänge beobachtet, welche unter Mitwirkung besonders differenzierter Antheridien erfolgen. Letztere werden an gewöhnlichen vegetativen Hyphen angelegt, und entstehen entweder aus den Gehäusezellen selber oder in deren Nähe. Ihre Ausbildung wird dadurch eingeleitet, dass die Endzelle des betreffenden Hyphenfadens anschwillt und sich dicht mit Plasma und Kernen füllt." The young antheridium now branches and finally assumes the shape of a hand. The trichogyne grows to meet the antheridium which attaches itself to its end: the antheridium now sends out further branches which encircle the under portion of the trichogyne. Through the mutual flattening of the antheridial cells a plectenchymatous tissue arises in which the trichogyne appears to be enclosed. The trichogyne now sends out short processes which press into the antheridial cells; the pressure thins the separating membrane, which finally becomes perforated in a sieve-like manner. "Nunmehr wandern die Kerne des Antheridiums durch die neugebildete Öffnung ein und durchziehen die Trichogyne, wo sie häufig perlschnurförmig hintereinander gereiht angetroffen werden. Auch die Querwände der Ascogonzellen, die sich anfangs ihrer Wanderung hindernd in den Weg stellen, werden aufgelöst und es können die Kerne den weiblichen Faden in seiner ganzen Länge durchziehen. Schliesslich häufen sie sich in den zentralen Endzellen an."

The further changes in the ascogonial cells are difficult to

follow, as they become stretched owing to the irregular growth in length of the perithecium. This is especially the case for the trichogyne and its neighbouring cells, which, having fulfilled their function, become resorbed, and can only be recognised in older stages as crushed remains. The asci appear to arise "als seitliche Ausstülpungen der Zentralen." The author promises a fuller account of this and other phyllogenous Ascomycetes. It would seem advisable to reserve any comments until this further contribution appears. It is hardly credible that an antheridium should grow out of the cells of the perithecial wall, and other points are still vague—and unusual.

BASIDIOMYCETES.

USTILAGINEAE.

M. Wilson (1915) has given a preliminary account of the life history and cytology of *Tuburcinia primulicola.* The conidial stage of the fungus *(Paepalopsis Irmischiae)* has been rarely recorded. The mycelium is intercellular, producing haustoria of the type usually found in the Ustilagineae. The fungus apparently persists in the host plant during the winter; in the spring it may be found in the peduncle and in the floral organs, usually situated peripherally. The mycelium is septate with uninucleate cells; the nuclei are small, with one deeply staining nucleolus. In young flowers the mycelium is particularly abundant in the lower part of the corolla tube, on the dorsal surface of the anthers and in the ovary between the ovules. In these places it becomes superficial and gives rise to large numbers of small unicellular uninucleate conidia. The conidia in the open flower are seen as meal-like masses, which glue together the stamens and partially fill the base of the corolla tube, having little chance of escape from there. Functional pollen is apparently formed and insects probably distribute the conidia along with this. The author was unable to infect healthy flowers with a mixture of pollen and conidia.

"In the open flower conidia may be found in all stages of conjugation; they become joined up in pairs by a short connecting tube, thus producing dumb-bell-shaped structures. In the conjugating pair a nucleus passes from one conidium to the other through the connecting tube. The nuclei are then found in close proximity in the one conidium, which later gives rise to one or more germ tubes. It is highly probable that the mycelium thus produced bears the chlamydospores," which are found in flowers in which conidia were previously formed. The chlamydospore groups are developed from coiled mass of hyphae, which contain conjugate nuclei—the mycelium being found in the superficial tissue of the placenta and packed in

between the ovules. In the young condition the spores are binucleate, but later on the nuclei fuse and the mature chlamydospores are uninucleate. Finally the tissue of the placenta, ovules and ovary wall disintegrate, and the spore masses are set free. Germination takes place readily in water, the process agreeing with the description given by Brefeld. "No conjugation of sporidia has been observed."

"The fungus is frequently placed in the genus *Urocystis*, but the presence of the conidial stage, the absence of sterile cells in the chlamydospore group, and the method of development of the sporidia lead to the conclusion that it is more correctly placed in the genus *Tuburcinia*."

The cytological results recorded in the Ustilagineae make it now certain that in most cases there is a well marked alternation between a uninucleate and a binucleate condition. Rawitscher's* work on *Ustilago* showed that the uninucleate condition arose at different stages of the life cycle in different species. *Tuburcinia primulicola* from the present investigation appears more akin to the Uredineae than do the previously studied forms, in that the different nuclear conditions are related to definite spore forms, the uninucleate condition to the conidial *(Paepalopsis)* stage and the binucleate condition to the chlamydospore *(Tuburcinia)* stage. It will be interesting to observe whether this relation is found to hold in other Ustilaginaceae.

UREDINEAE.

Welsford (1915) has studied the nuclear migrations in *Phragmidium violaceum*. It was with this species that Blackman (1904) worked, and recorded a reduced fertilization, the binucleate condition of the fertile cell of the aecidium originating by a migration into it of the nucleus of a neighbouring vegetative cell. Christman (1905) found that in the young aecidium of *Phragmidium speciosum* fertile cells occur "which incline toward each other, coming in contact in a region on their adjacent walls. . . . At the point of contact an opening is formed by solution of the cell wall and thus the protoplasts are brought into contact. The pore is small at first. . . . By gradual enlargement of the pore the upper halves of the protoplasts of the gametes unite to form a continuous cell mass which still shows plainly the two distinct bases." Thus the fertile cell which gives rise to the aecidiospores is formed. Most observers have found the Christman method to occur in the species they studied, and though they have found migrations similar to those recorded by Blackman,

* *Cf.* Trans. Brit. Mycol. Soc. IV., p. 154 (1913).

have regarded these as pathological. Welsford, therefore, has paid special attention to fixation. "A very careful and prolonged search has been made for any indications of fusions between fertile cells of the young aecidium, but without success; no case of this type of fertilization was found. Migrations of nuclei, such as were previously described by Blackman, occur regularly. The nucleus invariably passes from a vegetative to a fertile cell; sometimes the cells concerned belong to the same hypha and the nucleus passes from below upwards, and at other times the nucleus comes from a neighbouring hypha and passes in laterally. In no case was a migration found from one fertile cell to another." In very young aecidia the migrations occur in the middle region, while in rather older examples the cells of this region are already binucleate, and migrations are only found in cells immediately outside them. Sometimes the nucleus passes through a very small pore in the wall and thus becomes greatly constricted. This is the typical method according to Blackman—"The migrating nucleus is reduced to a narrow thread during the process, the actual aperture through which it passes being very small; neither before nor after its passage could a pit in the wall be observed." According to Welsford, the pore is more commonly rather larger and the nucleus is only slightly constricted during its passage. In a few cases the hole was of considerable size. "When it was found that the nuclei sometimes pass through a large hole on the cell-wall, it seemed unlikely that such holes would be later obliterated, and a careful search was made amongst the older binucleate cells, with the result that a few cases were observed." The cells from which the nuclei have migrated gradually lose their cytoplasm and become almost or quite empty: they form a fairly conspicuous layer surrounding the bases of the old fertile cells. "In spite of a careful search, fusion between two fertile cells was never observed, but no less than twenty-eight cases of migration of a vegetative nucleus into a fertile cell were found. It is also important to note . . . that in fairly young aecidia the migrations are found to occur only in connexion with the cells immediately peripheral to the central mass of binucleate fertile cells. This special localization of the 'migrations' and the absence of lateral fusion of fertile cells are in themselves sufficient to show that the passage of a vegetative nucleus into a fertile cell is the normal method of origin of the binucleate condition in this form. . . . It may be mentioned that the paraphyses towards the periphery of the aecidium are often multinucleate, and nuclear divisions occur frequently in them." It is most satisfactory to have a confirmation of Blackman's classical results. It would seem that

in *Phragmidium subcorticium* we have a species which shows both methods of fertilization (vide infra Moreau). In such a species the transition between the two methods of nuclear migration might be observed. It does not appear that it can possibly be merely a matter of orientation as suggested by Olive (1908).

Moreau (1914) has published the full account of her studies on the Uredineae, of which she has given several preliminary notes.* She describes the origin of the binucleate condition in several species. In *Phragmidium subcorticium*, an autoecious eu-form, the caeoma which represents the aecidial stage can be followed by several caeoma forms similar to the first. Bandi (1903) found that by sowing caeomaspores on various roses the resulting mycelium can give rise again to caeomas, and this he succeeded in accomplishing up to four times. Moreau studied the first formed caeoma. The mycelium which gives rise to it is uninucleate. "C'est donc au cours du développement de ce premier caeoma que prennent place les phénomènes de duplication des noyaux." The uninucleate mycelium forms stromata which produce two different kinds of fructifications: one, subcuticular, gives rise to the spermogonia which are already mature when the other, subepidermal, begins to develop aecidia. In aecidial formation the mycelial cells of the hyphal mass nearest to the epidermis elongate perpendicularly to it, and form a palisade layer of uninucleate subepidermal cells. The nuclei of these cells soon divide and this division is followed by a cell division forming a smaller upper ("sterile") cell and a lower, larger ("fertile") cell. There is usually only a single superior cell cut off "mais il arrive parfois, le plus souvent aux points de rencontre de deux cellules épidermiques, c'est-à-dire aux endroits où il y a de la place, que la cellule basale découpe à sa partie supérieure une seconde cellule stérile, parfois une troisième, parfois même une quatriéme." On one occasion a whole sorus of more than twenty basal cells was encountered, each with at least two sterile cells, generally with three, and in the space separating two epidermal cells, four. Fromme (1912)† found two sterile cells superposed upon the basal cells in *Melampsora Lini:* in this case the upper cell of the two first formed divided. "Chez le *Phragmidium subcorticium* que nous avons étudié toutes les cellules stériles naissent aux dépens des cellules basales qui découpent successivement à leur partie supérieure une, puis deux, trois et même quatre petite cellules. Le noyau de ces petites cellules reste petit, diminue de taille et disparaît." The nuclei of the uppermost cells degenerate first and the others

* *Cf.* Trans. Brit. Mycol. Soc. IV., p. 279 (1914); V., p. 109 (1915).
† *Cf.* Trans. Brit. Mycol. Soc. IV., p. 159 (1913).

in succession; this is followed by a degeneration of the cells themselves, until in an old sorus no trace of the sterile cells can be seen. The basal cells fuse in pairs, following the method described by Christman (1905). The dissolution of the median wall begins in the upper portion and progresses downwards. There is no apparent difference between the fusing cells. The sterile cells are usually separated before the fusion, but sometimes fusion takes place between a cell surmounted by a sterile cell and one in which the latter has not yet been differentiated. In exceptional cases a fusion of three basal cells was observed. Besides Christman's method "nous en avons observé un autre, beaucoup plus rare, à savoir la formation de cellules binucléées par disparition de la membrane entre une cellule basale et une cellule mycélienne sous-jacente" or "entre une cellule basale et une cellule inférieure quelconque ne la prolongeant pas." This type of fusion cell can be recognised by its length and its superposed nuclei. Moreau does not suggest that these phenomena are pathological. It is most interesting to find that they occur in a species so closely allied to *Phragmidium violaceum* (see p. 291). The nuclei divide simultaneously, and the cells containing them detach from their upper portion short cells in rows. "Le jeu des cellules basales, un moment interrompu par les phénomènes de cytogamie, produit donc à nouveau des chaînes de cellules mais les cellules formées sont cette fois binucléées."§

Another eu-form, *Puccinia Violae* was investigated. This species, which has a well-marked aecidium stage, was studied by Fromme* (1914). The mycelium first forms a homogeneous and undifferentiated mass of hyphae grouped beneath the lower epidermis of the leaf. The cells are poor in protoplasm and uninucleate. The deepest cells soon enrich their protoplasm, their nuclei actively divide, and a rapid cell division takes place. On the other hand, the superficial cells increase in volume, become poorer in contents, and their nuclei diminish in size. Thus an upper portion formed of wide, almost empty hyphae and a lower portion with short hyphae and dense contents can be distinguished. The upper portion is sterile; its cells increase further in size, the protoplasm impoverishes more and more, and the nuclei degenerate; in the end it becomes flattened against the epidermis. The lower portion is fertile; the short hyphae elongate considerably and grow towards the centre of the mass. "Il peut y avoir bifurcation des extrémitiés de ces hyphes." A little later the elongated hyphae are sometimes surmounted by small cells which recall by their position and size the sterile cells of a young caeoma:

§ For details of nuclear division *cf.* Trans. Brit. Mycol. Soc. V., p. 109 (1915).
* *Cf.* Trans. Brit. Mycol. Soc. V., p. 114 (1915).

the nuclei of these cells are normal and quite similar to those of the elongated sub-adjacent cells; the protoplasm is dense. In one case three or four rows of small cells surmounting longer cells were found, the nuclei of those nearest the surface possessing a very small nucleus which could be regarded as degenerate. This recalls the description in *Phragmidium subcorticium.* "De telles cellules ne se retrouvent que rarement dans les sores âgés, soit qu' elles ne se forment pas toujours, soit qu' elles dégénèrent rapidement, soit qu'elles se transforment." The elongated cells are the future basal cells and contain a large nucleus and abundant protoplasm. They soon fuse in pairs, the dissolution of the median wall proceeding from above downwards as in *Phragmidium subcorticium.* Generally the resulting binucleate cells are in direct contact with the flattened sterile hyphae above described, but they are sometimes surmounted by two small uninucleate cells which may or may not show degenerate contents. As in *Phragmidium* the nuclei of the basal cells divide, and an upper portion is cut off which becomes the aecidiospore mother cell, dividing in its turn to give rise to the aecidiospore and the intercalary cell.

The pseudoperidium forms tardively. It results from the transformation of the most external spores of the sorus. In the upper portion the end spores of the chains, *i.e.*, the first formed spores, show all stages between typical aecidiospores and characteristic peridial cells of large size, with walls thickened especially on the external face, a small amount of parietal protoplasm and lateral nuclei which degenerate. Below these cells in the young condition intercalary cells are still visible. At the sides, all the spores of the aecidial chain take part in the formation of the peridium: the intercalary cells are pushed to one side. This agrees with the account of peridium formation given by Fromme (1914)† and Kurssanow (1914).† Moreau thinks the dehiscence of the aecidium is comparable to the opening of anthers, the peridium playing an analogous mechanical *rôle* to that of the fibrous layer.

The account given by Moreau agrees with that of Fromme except in the description of the superficial sterile tissue of the initial hyphal mass. Fromme applied the name pseudoparenchyma to this tissue and believed it to arise from the converging hyphae of the fertile tissue, *i.e.*, that it is formed similarly to the sterile cells in a young caeoma. Moreau, on the other hand, holds that this tissue is only ordinary vegetative mycelium: "nous avons pu observer tous les intermédiaires entre les petites de la partie supérieure sous-épidermiques, restées

† *Cf.* Trans. Brit. Mycol. Soc. V., p. 119 and p. 120.

à l'état de cellules mycéliennes végétatives ordinaires, et les grosses cellules à protoplasme pauvre qui surmontent le tissu fertile." The small cells in chains which are superposed on the basal cells are considered by Fromme as young cells of the sterile tissue, while Moreau believes them to correspond to the sterile cells found in young caeomata. It is in the superficial caeoma that sterile cells are most abundant. They are apparently fairly rare in the more deeply seated aecidium, though Blackman and Fraser (1906) suspected their presence in *Uromyces Dactylidis* and *Puccinia poarum*, while Dittschlag (1910) encountered them, though very rarely, in *Puccinia Falcariae*. According to Moreau "L'absence de cellules stériles, la suppression d'une phase d'activité des cellules basales avant la cytogamie qui double le nombre de leurs noyaux, ou au moins la disparition de la régularité avec laquelle le phénomène a lieu dans les caeomas, paraissent être caractéristiques des écidies proprement dites."

The full account of the aecidium growing on *Euphorbia silvatica* (=*E. amygdaloides*), of which the spores and mycelium are uninucleate, is now given.§ The spores, on germinating (in a decoction of the host plant) give rise to a promycelium with two or three septa, thus showing that the fungus is a species of *Endophyllum*. It differs from *E. Euphorbiae* only in the fact that its spores are uninucleate, and Moreau therefore proposes to make it a variety, *Endophyllum Euphorbiae* var. *uninucleatum* or a species *E. uninucleatum*.‖ The development of this fungus is very similar to that of *Puccinia Violae*. On the lower surfaces of the leaves below the subepidermal cells, the parasite forms thick layers of homogeneous cells which are small, isodiametric with

§ *Cf.* Trans. Brit. Mycol. Soc. III., p. 363 (1912).

‖ It is perhaps necessary to point out that when any investigator ventures upon describing a new species the description ought to be drawn up according to the method adopted by systematists. The International Rules of Botanical Nomenclature state that "the publication of names of new groups of recent plants will be valid only when they are accompanied by a Latin diagnosis," and also that "a species or a subdivision of a species, announced in a work, with a complete specific or varietal name, but without diagnosis or reference to a former description under another name is not valid." It is much more satisfactory to have such a diagnosis than to have to pick out the specific characters from a long description often crowded with unessential details from the point of view of the systematist. It is also unsatisfactory to give a fungus two different ranks when first describing it!

The name of the *Endophyllum* on *Euphorbia amygdaloides (silvatica)* is—

Endophyllum Euphorbiae-silvaticae (DC.) Wint. in Rabenh. Krypt. Fl. Pilze I., p. 251 (1881).

Aecidium Euphorbiae-sylvaticae DC. Fl. fr. II., p. 241 (1805).

Endophyllum Euphorbiae Plowr. Brit. Ured. p. 228 (1889).

The nomenclature of Uredineae starts at Persoon's Synopsis (1801). *Aecidium Euphorbiae* of this work (p. 211) is not the species under review, but is the aecidium on *Euphorbia Cyparissias*, i.e., *Uromyces Pisi* and its allies.

sparse, finely granular protoplasm, and a single medium sized nucleus. Soon each mass becomes differentiated into two parts, an upper portion formed of wide, irregular almost completely empty hyphae and a lower portion composed of short cells with dense contents. This differentiation becomes accentuated and the lower cells orientate perpendicularly to the surface of the leaf. "Quand ces hyphes fertiles ont acquis une certaine longueur ils sont devenus plus larges. A aucun moment ils ne détachent de petites cellules stériles à leur extrémité supérieure. A aucun moment non plus ils ne se fusionnent par paires; à aucun moment ils ne contractent d' union avec les cellules sous-jacentes." The spore mother cells are, like the basal cells which give rise to them, uninucleate. They are in direct contact with the wider hyphae of the upper portion which become flattened and have degenerate nuclei: when the aecidium is mature these cells disorganise. Each aecidiospore mother cell divides into a larger upper aecidiospore and a smaller lower intercalary cell in the usual manner. "Ecidiospore et cellule intercalaire sont uninucléées." The peridium is formed from the uppermost aecidiospores of the chains and the whole of the spores in the outermost chains. As throughout the sori, these cells are uninucleate. The aecidium in this fungus arises more deeply than in *Puccinia Violae*, and correlated with this there is an entire absence of sterile cells surmounting the basal cells. "*Endophyllum uninucleatum* occupe donc par les caractères de ses écidies une place plus élevée que *Puccinia Violae* plus évolué lui-même que *Phragmidium subcorticium.* Les *Endophyllum* nous apparaissent ainsi comme des formes récentes." Barclay (1891) and Grove (1913) have, on the other hand, regarded *Endophyllum* as primitive.

The divisions of the nuclei of the basal cells and of the aecidiospore mother cells were studied. The nuclei are of the same size as those of typical *E. Euphorbiae-silvaticae* At rest, they are generally rounded with an excentric spherical nucleolus, a reticulate nucleoplasm, a clear membrane and a plainly visible centrosome. During division the net transforms directly into two chromosomes, while the nuclear membrane disappears and the nucleolus is extruded into the cytoplasm. The two chromosomes divide longitudinally and then place themselves in the middle of the spindle, which by this time has appeared. The two halves of each chromosome separate and the following stage shows four daughter chromosomes which travel in pairs to opposite poles. The division is thus an ordinary vegetative division and is such as occurs in the vegetative hyphae of *Phragmidium subcorticium.** Moreau regards the

* *Cf.* Trans. Mycol. Soc. IV., p. 109 (1915).

nuclei as haploid and thus rejects the theory of Fischer (1912) who suggested that a fusion of nuclei occurred at an early stage of development. Vuillemin's view (1912) that the aecidium was a first aecidial form and would be followed by a second, in which normal fusion would take place, is also untenable now that the full research (with a successful germination of the spores) is published. Moreau regards the sterile ("buffer") cells as representing degenerate female gametes *(preaecidiospores)*† and, therefore, in *E. Euphorbiae-silvaticae* var. *uninucleatum* "on peut dire qu'il y a apocytogamie; celle-ci entraîne la suppression du tronçon binucléé, l'apogamie (apokaryogamie) dans la téleutospore, par suite la suppression de la réduction chromatique." The suggestion of Guilliermond (1913) and Ramsbottom (1912) that it is a case of ordinary parthenogenesis is adopted by Dangeard (1914).¶ The nuclear divisions which occur at the germination of the spores were not studied. The only other case known of a uninucleate aecidium was found amongst normal examples of *Aecidium punctatum* by Kurssanow (1914).‡ An analogous case is the uninucleate mycelium etc. of Maire's genus *Godfrinia.***

Moreau also studied *Puccinia malvacearum*, *P. Buxi*, *Uromyces Ficariae* and *U. scillarum*,§ which are all species possessing only teleutospores. *Puccinia malvacearum* has previously been studied by Blackman and Fraser (1906) and by Werth and Ludwigs.‖ The vegetative mycelium is composed of uninucleate cells and forms masses of pseudoparenchymatous tissue under the epidermis. The upper cells of this tissue elongate and increase somewhat in width. They arrange themselves in pairs and the median wall dissolves progressively downwards. From this fusion cell a chain of two or three binucleate cells is formed which terminates in the teleutospore mother cell, from which the teleutospore and its stalk arise. Fusion sometimes occurs between cells of unequal size, but no nuclear migration as recorded by Werth and Ludwigs was seen. "D'après nos observations la condition binucléée s'établit ici par un phénomène de cytogamie

† *Cf.* Trans. Brit. Mycol. Soc. V., p. 113 (1915).

¶ Le Botaniste XIII., p. 323 (1914).

‡ *Cf.* Trans. Brit. Mycol. Soc. V., p. 121 (1915).

** Madame Moreau (Bull. Soc. Mycol. Tr. XXXI., pl. IV. (1915)) has since published two microphotographs of sections of a young and an old aecidium of *E. Euphorbiae-silvaticae* var. *uninucleatum* which show clearly the uninucleate condition.

§ *U. scillarum* sometimes shows uredospores amongst the teleutospores.

‖ Trans. Brit. Mycol. Soc. IV., p. 157 (1914).

semblable à ceux que nous avons rencontrés dans les Urédinées pourvues d' écidies."

Puccinia Buxi was the species in which Dangeard and Sappin-Trouffy (1893) first observed nuclear fusion in the teleutospore. Sappin-Trouffy (1896) recorded a uninucleate mycelium and young binucleate teleutospores. The mycelium forms masses of uninucleate cells between the cells of the host plant which are penetrated by haustoria. Under the epidermis, often on both surfaces of the leaves, well developed mycelial stromata develop, of which the upper cells are elongated. These cells press together and later fuse. The fusing cells may apparently be sometimes "diversement placées." The fusion cell gives rise to one or two binucleate cells, the end one of which is the teleutospore mother cell, which on division gives rise to the teleutospore with its pedicel.

Uromyces Ficariae shows, according to Sappin-Trouffy (1896) a binucleate mycelium. Blackman and Fraser (1906) found that the vegetative hyphae are uninucleate but that the mycelium at the base of the teleutosorus is binucleate. Moreau finds that the vegetative mycelium is uninucleate. The hyphae form stromata with uninucleate cells, under the epidermis. "Plus tard on trouve des cellules uninucléées et des cellules binucléées. La duplication des noyaux est réalisée par la fusion de deux cellules voisines." Several generations of binucleate cells are formed—before teleutospore formation. The terminal cell of each binucleate chain becomes the basal cell; it elongates, its nucleus divides, and a septum cuts off from the upper portion the teleutospore mother cell. "Plusieurs téleutospores sont souvent produites par la même cellule basale qui se ramifie."

In *Uromyces scillarum* Blackman and Fraser (1906) found a binucleate vegetative mycelium. Moreau confirms this, finding masses of hyphae with binucleate isodiametric cells. The upper cells enlarge, elongate and become directly the basal cells of the sorus. "On n'observe aucun phénomène de cytogamie à la base du sore." Thus in the microforms studied there is a transition from the case in which the teleutospores are borne on a uninucleate mycelium to that in which the vegetative mycelium is binucleate.

Moreau gives a detailed account of the reduction divisions in *Coleosporium* spp., the preliminary notes of which were reviewed in the last paper of this series.* It is perhaps sufficient to point out here that the process is "une préréduction hétéro-homéotypique préparée par une pseudo-réduction prophasique par parasyndese." The work is a valuable contribution to the study of the Uredineae.

* Trans. Brit. Mycol. Soc. IV., p. 109 (1915).

Dietel (1914) has a short note on the nuclei in the teleutospores of *Uromyces Rumicis* and *U. Ficariae*. The teleutospores of these species are exactly alike, and Tranzschel was led to suspect some connection between them similar to that which he showed existed between *Puccinia fusca* and *P. Pruni-spinosae*, which have also very similar teleutospores. He found the teleutospores of *Uromyces Rumicis* produced an aecidium on *Ranunculus Ficaria* (1905), and in 1909 infected *Rumex obtusifolius* with aecidiospores from the *Ranunculus*. There is also on *Ranunculus Ficaria* the aecidium of *U. Poae*, and this has seemed to complicate matters. In any case, judging from the work of Bubák (1906) and Krieg (1906) it cannot be said that Tranzschel's results can be safely accepted. Dietel has discovered a most interesting point concerning the teleutospores of the two species which seems to have been overlooked. "Diese besteht darin, dass jede Spore zwei dicht nebeneinanderliegende Kerne hat [in *U. Rumicis*] . . . . Das gleiche gilt nun auch für *Uromyces Ficariae*, auch hier hat jede reife Teleutospore ein Synkaryon." The fact that the ripe teleutospores contain two nuclei which apparently do not fuse (which as far as the present writer is aware is the only recorded case of this phenomenon) greatly strengthens Tranzschel's position.

It has yet to be shown whether there is not a deferred fusion; and, in any case, whether an ordinary quadriseptate promycelium is formed on germination; also whether the nuclear divisions which produce the sporidial nuclei are ordinary vegetative divisions or not. It may be found that the observations of Olive† (1913) on perennating sporophytic mycelia will give the clue to the life cycle—but observations are what are really needed.

HYMENOGASTRINEAE.

Conord (1915) has investigated the development of *Secotium agaricoides*. The genus *Secotium* (including *Endoptychum* Czern. and *Elasmomyces* Cav.) is usually placed in the Gasteromycetes. It resembles a puff-ball in general appearance but stands on a short stalk which passes through the body of the fungus as a columella. The interior is filled with branched and much folded lamellae. Sometimes the body does not dehisce; in other cases it splits lengthwise or the peridium separates slightly from the stalk after the manner of an agaric. From the account of the development "it is clear that the carpophore of *Secotium agaricoides* presents in its origin and development an exact counterpart of that of *Agaricus*

† *Cf.* Trans. Brit. Mycol. Soc. IV., p. 273 (1914).

(Atkinson 1906, 1914). There is at first a universal veil like that of several evolvate agarics *(Agaricus, Armillaria* and *Stropharia).* There is an ill-differentiated partial veil. The origin of the hymenophore agrees precisely with that of all recently reported agarics, except *Hypholoma* (Allen 1906) and *Coprinus* (Levine 1914). The marginal growth of the gill system is also familiar in the mushrooms. The columella comes into being exactly as does the stipe of mushrooms. Indeed, we might well speak of stipe and pileus of *Secotium,* rather than of peridium and columella. The basidia and spores have the shape, size and arrangement found in agarics. The failure of the cap and gills to expand, the drying up of the trama into a friable mass of tissues and spores, the olive-brown colour of the spores, and the freedom of the spores to 'puff' when the exposed mass is touched, are all lycoperdinean characters." The cell structures of *Secotium* present nothing novel. In sections of the earliest stages there are in the ring of active growth a few hyphae which are twice as stout as others: they stain early and are without granules of any kind. The end walls of the cells of the mycelium usually show the little central mass of stainable material associated by Strasburger with the pores. "In several instances, the cells of the tramal hyphae had two distinct nuclei. Metachromatic bodies are numerous, especially in the hymenium and regions of active growth. Many paler bodies were seen along the walls of some cells." The rhizomorph connected with the base of the carpophore is composed of three kinds of hyphae: (1) Most hyphae are very slender, homogeneous or slightly granular; they form the fundamental tissue of the entire structure. (2) Among these are groups or strands of larger hyphae which show distinct nuclei, certain globular bodies and numerous square crystals. They run mostly longitudinally and are much tangled: they are not found in the carpophore. (3) On the surface of the rhizomorph are many slender hyphae with very thick walls; in places they form a rather compact layer, but they occasionally extend into the centre of the rhizomorph. "The young basidium possesses two nuclei near the middle of the cell, usually lying in the longitudinal axis of the cell. These nuclei, like those of the mycelium generally, are small, sharply outlined, with one large nucleolus and little or no other visible substance. Later a single large nucleus of similar structure is found near the distal end of the basidium. Although satisfactory fusion stages were not found, there is doubtless a fusion of nuclei to form this one large nucleus. Still later, two and then four nuclei are found, clustered about the apex of the basidium. The mitoses were not observed. The four sterigmata then grow out symmetrically and a spore

forms on each. The entrance of the nuclei into the spores was not observed, but some of the spores were clearly seen to possess a single nucleus." The cytology of the fungus, as far as it has been made out, thus agrees with that of most Hymenomycetes. The author's remarks on the systematic position are interesting. Fischer (in Engler and Prantl's Pflanzenfamilien) places the genus, together with *Cauloglossum*, *MacOwanites*, *Polyplocium* and *Eyrophragmium*, in the Secotiaceae of the Hymenogastrineae. According to Conord, *S. agaricoides* is like *Psalliota* in development, and not like *Phallus* or *Mutinus*, "nor can the stipe and columella of *Secotium* be likened to the stalk of a phalloid; for the phalloid stem probably represents a sterilized gleba, and is therefore comparable with the sterile base of a *Lycoperdon*. But the columella of *Secotium agaricoides* is in its origin, development, and structure strictly agaricinian. There would seem to be no support whatever for relating our plant to the Phallaceae. The likeness of *Secotium* to a puff-ball . . . . though quite real, is decidedly superficial, and cannot carry much weight." In the estimation of the author the plant would best be placed near *Psalliota*. "It is to be regarded as a primitive or arrested agaric,—perhaps a paedogenic form, reaching its reproductive maturity in the 'button' stage." There is no doubt that the classification of some of the aberrant fungus genera will be simplified by morphological studies on fresh or preserved material. Much of the difficulty is due to the fact that investigations on the rarer of these genera have, of necessity, been made on dried herbarium specimens. It has become much more frequent for collectors to preserve all stages of any interesting species in spirit, and thus mycologists, if they are not able to collect their own material, now have much better opportunities of making out the essential structural details.

NIDULARIACEAE.

Leininger (1915), in an account of some physiological observations on *Cyathus striatus*, states that the mycelium, which is rich in clamp-connections, is binucleate, and thus agrees with the majority of the Basidiomycetes.*

* *Cf. Nidularia* (e.g.), Trans. Brit. Mycol. Soc. iii. p. 367 (1912).

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A LIST OF THE BRITISH SPECIES OF PHYCOMYCETES, ETC., WITH A KEY TO THE GENERA.

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There has been no list of British Phycomycetes published since G. Massee's "British Fungi: Phycomycetes and Ustilagineae," which appeared in 1891. The present list includes all the records that the compiler has been able to trace. Notes on some of these, and on certain unsatisfactory records, together with a few notes on nomenclature, are treated in an additional paper. The generic keys have been drawn up with the aid of the various monographs relating to the fungi considered. There is need in this country for a great deal of systematic work in the lower groups of fungi; in the generic key the aim has been to give sufficient characters to ensure that a genus new to Britain will not fit in with the whole of a description in the artificial key.

As the groups Phytomyxinae (Plasmodiophoraceae) and Acrasieae are not elsewhere treated they have been listed here, as have also, for convenience, the anomalous group Protomycetaceae. The Myxomycetes of this country have been adequately described and listed: it is unnecessary to merely copy the list here.

MYCETOZOA.

Organisms without chlorophyll having as a vegetative stage either distinct amoeboid cells or a plasmodium composed of numerous cell units each unwalled; reproduction by spores which are free or produced in sporangia of various forms; spores on germination producing either zoospores or amoeboid bodies which unite to form either new plasmodia or pseudoplasmodia.

Intercellular parasites; vegetative stage plasmodial; plasmodium giving rise simultaneously, or by a successive differentiation to spores which on germination produce each a motile swarm cell ..... **PHYTOMYXINAE** (Plasmodiphoraceae)

Saprophytic.

Usually coprophilous; vegetative stage consisting of independent myxamoebae which undergo multiplication by division; myxamoebae typically aggregated into colonies (pseudoplasmodia)forming either spores or pseudospores held together by a mucous substance and borne in stalked or sessile naked masses **ACRASIEAE**

Vegetative stage consisting of a plasmodium formed by the fusion of swarm cells which have passed through a flagellate stage; plasmodium giving rise to fruits consisting of supporting structures and spores; in the *Endosporeae* these take the form of sporangia in which the free spores are developed; in the *Exosporeae* they consist of sporophores bearing numerous spores on their surface ..... **MYXOMYCETES**

PHYTOMYXINAE.

Spores free, spherical ..... **PLASMODIOPHORA**

Spores united into groups.

Spores collected into hollow spheres ..... **SOROSPHAERA**

Spores collected in masses.

Spores forming a spongy spore ball ... **SPONGOSPORA**

Spores forming groups of various shapes (*e.g.*, spheres, ellipsoids) ..... **LIGNIERA**

ACRASIEAE.

Myxamoebae possessing slender elongated pseudopodia. Sori consisting of spherical masses of spores or of a chain of spores, stalked, the stalks composed of distinct parenchyma-like cells with cellulose walls **Dictyosteliaceae**

Dictyosteliaceae.

Stem not, or only slightly and irregularly branched. Sorus roundish ..... **DICTYOSTELIUM**

Phytomyxinae.

PLASMODIOPHORA Woron.

Brassicae Woron.

SOROSPHAERA Schroet.

Veronicae Schroet.

SPONGOSPORA Brunch.

subterranea (Wallr.) Lag.

LIGNIERA Maire et Tison

Junci (Schw.) Maire et Tis.

graminis (Schw.) Schw.

Bellidis Schw.
Menthae Schw.
Alismatis Schw.

Acrasieae.

DICTYOSTELIACEAE.

Dictyostelium Bref.
mucoroides Bref.

PHYCOMYCETES.*

Vegetative mycelium usually continuous, except at the formation of reproductive organs or when old, sometimes unbranched and the whole structure forming a sporangium, sometimes with a much-branched mycelium with special reproductive structures. Asexual reproduction by means of either zoospores or conidia; sexual reproduction by oospores or zygospores.

Sexual reproduction, when present, by means of oospores. Mycelium present or wanting. Asexual reproduction by zoospores or conidia ..... **OOMYCETES**

Sexual reproduction by means of zygospores. Mycelium present. Asexual reproduction by sporangial spores or acrogenous conidia: chlamydospores sometimes present **ZYGOMYCETES**

OOMYCETES.

Mycelium either quite absent or feebly developed.

Usually only one sporangium developed from the vegetative body, or by division forming a sporangial sorus. Sexual reproduction known in only a few genera **Chytridiineae**

Usually the whole vegetative body divided by cross walls into a chain of sporangia which develop partly into zoosporangia and partly to antheridia and oogonia; oogonium with only one oospore **Ancylistineae**

Mycelium strongly developed.

Antheridia forming motile spermatozoids which pass into the oogonium ..... **Monoblepharidineae**

Antheridia not forming motile spermatozoids.

Asexual reproduction by zoospores. Oogonia usually with several oospheres. Water forms **Saprolegniineae**

* If, as stated by Bucholtz (*Cf.* Trans. Brit. Mycol. Soc. IV., p. 137 (1913)) *Endogone* Link is a Phycomycete, we should have a third division of the Phycomycetes *(Endogoneae)* characterised chiefly by its subterranean habit. There are two British species, *E. lactiflua* B. et Br. and *E. pisiformis* Link.

Asexual reproduction by conidia borne on branched conidiophores: conidia sometimes giving rise to zoospores on germination. Oogonia with a single oosphere. Land forms .... **Peronosporineae**

Chytridiineae.

Thallus naked, spherical or ellipsoid, never branched nor mycelium-like, surrounding itself with a membrane shortly before the whole of it becomes transformed into a sporangium or a sporangial sorus. (Holocarpous.) Sexual reproduction known only in one genus *(Olpidiopsis)*. Always endophytic **MYXOCHYTRIDIINAE**

Thallus surrounded by a membrane from the first, never wholly spherical or ellipsoid; often organized into a mycelial and a reproductive portion, the latter being frequently epiphytic: mycelium usually only feebly developed, fine, thread-like and generally rhizoidous, attached to the base or to the whole of the sporangium. (Holocarpous or eucarpous.) Sporangia arising as terminal or intercalary swellings or resting sporangia may be formed in a manner similar to oospores or zygospores. Appendage cell often present **MYCOCHYTRIDIINAE**

MYXOCHYTRIDIINAE.

Sporangia always single, spherical or ellipsoid, seldom vermiform. Zoospores uniciliate. Parasitic in various organisms ..... **Olpidiaceae**

Zoosporangia in sori.

Sorus not enclosed in a separate membrane. Zoospores biciliate. Parasitic principally in Saprolegniineae **Woroninaceae**

Sorus enclosed in a separate membrane. Zoospores uniciliate. Parasitic principally in land plants **Synchytriaceae**

Olpidiaceae.

Zoosporangial membrane closely applied to the wall of the host. Fungus parasites ..... **PLEOLPIDIUM**

Zoosporangia lying free in the host cells.

Zoosporangia opening by a pore. Resting sporangia irregular, globose or polyhedral with projecting corners. Root parasites ..... **CHRYSOPHLYCTIS**

Zoosporangia provided with beaks.

Beak generally single, often elongate. Resting sporangia smooth, without appendage cell. Vegetative body spherical or ellipsoid ..... **OLPIDIUM**

Beaks many, often arranged in two opposite rows. Vegetative body vermiform ..... **ECTROGELLA**

Woroninaceae.

Zoosporangial sori lying free in the host cells ..... **WORONINA**

Synchytriaceae.

Resting sporangia with thick brown membrane. Protoplasm often brightly coloured. Parasitic in land plants **SYNCHYTRIUM**

Mycochytridiineae.

Mycelium mostly root-like and confined to one or two host cells, connected with a single sporangium. Zoosporangia epiphytic, usually single. Resting sporangia usually arising in a similar manner to the zoosporangia, seldom by fusion or as intercalary swellings ..... **RHIZIDIACEAE**

Mycelium wide-spread with terminal and intercalary swellings which develop into zoosporangia and resting sporangia. Appendage cells often present **CLADOCHYTRIACEAE**

RHIZIDIACEAE.

Mycelium delicate, generally confined to one host cell, usually branched and rhizoidous, arising from base of sporangium.

Sporangia epiphytic ..... **Rhizophidieae**
Sporangia endophytic ..... **Entophlycteae**

Mycelium usually tubular and wide spreading. Sporangium usually with a subsporangial vesicle. Resting sporangia often arising by a sexual process **Rhizidieae**

Rhizophidieae.

Mycelium thread-like throughout, often scanty, without subsporangial vesicle ..... **RHIZOPHIDIUM**

Mycelium with spherical, subsporangial vesicle **PHLYCTOCHYTRIUM**

Entophlycteae.

Sporangia without subsporangial vesicles. Resting sporangia with smooth membrane ..... **ENTOPHLYCTIS**

Sporangia with subsporangial vesicles. Resting sporangia with prickly membrane ..... **DIPLOPHLYCTIS**

Rhizidieae.

Zoosporangia free with mycelium projecting from all sides and penetrating the cells of the host. Resting sporangia arising by the fusion of two individuals **POLYPHAGUS**

CLADOCHYTRIACEAE.

Resting sporangia globose or elliptical, seldom flattened on one side; appendage cells attached to the wall by a short hypha. Causing discolouration or swelling of host plant ..... **PHYSODERMA**

Resting sporangia always flattened on one side or indented where the appendage cells, which disappear at maturity, are attached by a short stalk. Often causing considerable deformation of the host plant, and more or less dissolving the plant tissue **UROPHLYCTIS**

ANCYLISTINEAE.

The genus RESTICULARIA Dangeard is usually at present doubtfully placed in the Ancylistaceae, but it is probable that a new family will have to be made for its reception when its life history is more fully known, assuming previous statements to be correct.

Monoblepharidineae.

Mycelium unseptate, little branched **Monoblepharidaceae**

Monoblepharidaceae.

Zoospores uniciliate or biciliate..... **MONOBLEPHARIS**

Saprolegniineae.

Vegetative filaments of uniform width and not constricted into segments. Oospheres one to numerous; oospores usually with smooth membrane... **Saprolegniaceae**

Vegetative filaments constricted into segments. Oospheres single; oospores with thick usually characteristically sculptured membrane ..... **Leptomitaceae**

Saprolegniaceae.

Spores not swarming but immotile and germinating within the zoosporangium ..... **APLANES**

Zoospores normally leaving the zoosporangium by a common mouth.

Zoospores immediately dispersing, diplanetic.

Zoosporangium clavate containing many rows of spores. Oogonium with several oospheres ..... **SAPROLEGNIA**

Zoosporangium filiform containing a single row of spores. Oogonium with only one oosphere **LEPTOLEGNIA**

Zoospores collecting into a hollow sphere at the mouth of the sporangium on escaping.

Zoosporangium clavate containing many rows of spores. Oogonium with many oospheres ..... **ACHLYA**

Zoosporangium filiform containing a single row of spores. Oogonium with a single oosphere **APHANOMYCES**

Zoospores each escaping by a separate perforation in the zoosporangial wall, which remains as a net-work
DICTYUCHUS

Leptomitaceae.

Zoospores immediately dispersing. Resting spores absent
APODYA

Zoospores showing feeble swarming and encysting near zoosporangium. Thick-walled resting spores present
APODACHLYA

Peronosporineae.

Hyphae bearing conidia and sporangia not clearly differentiated from the vegetative mycelium.....**Pythiaceae**

Conidiophores, short, thick, subepidermal; conidia in chains
Cystopodaceae

Conidiophores more or less long, superficial, simple or branched, conidia not catenulate **Peronosporaceae**

Pythiaceae.

Zoosporangia spherical or oval, many times broader than the mycelium; zoospores formed outside of the zoosporangium ..... PYTHIUM

Cystopodaceae.

Conidiophores unbranched, forming a thick hymenial layer under the epidermis, which is finally ruptured
CYSTOPUS

Peronosporaceae.

Conidiophores unbranched with swollen tip studded with a number of short sterigmata which each bear a conidium; conidia germinating as zoosporangia
BASIDIOPHORA

Conidiophores branched in various ways.

Conidiophores dichotomously branched; conidia germinating by a germ tube.

Conidiophores with subapical disc-shaped enlargements from which the ultimate branchlets bearing the conidia arise apically; germ tube arising from the apex of the conidium ..... BREMIA

Conidiophores without subapical disc; germ tube arising from the side of the conidium ..... PERONOSPORA

Conidiophores not dichotomously branched; conidia germinating as zoosporangia.

Conidiophores mycelial, irregularly branched; at first simple bearing a single apical conidium which is pushed to one side by a lateral branch originating below it; conidiophores with irregular thickenings below the apparently lateral conidia PHYTOPHTHORA

Conidiophores with lateral branches developed normally.
Conidiophores fugacious, stout, sparingly branched; oospore united to the oogonial wall ... SCLEROSPORA
Conidiophores persistent, slender, usually freely branched; oospore free from the oogonial wall ..... PLASMOPARA

ZYGOMYCETES.

Asexual spores borne in sporangia, which are represented in some genera by conidia-like bodies **Mucorineae**
Asexual spores constricted singly from the apex of the conidiophores ..... **Entomophthorineae**

Mucorineae.

Asexual reproduction by spores contained in sporangia SPORANGIOPHORAE
Asexual reproduction by conidia produced either solitary or in chains ..... CONIDIOPHORAE

SPORANGIOPHORAE.

Sporangia without a columella, membrane diffluent. Zygospore enclosed in a carpospore formed by interlacing hyphae ..... **Mortierellaceae**
Sporangia provided with a columella.
Sporangia generally only of one kind, multisporous.
Sporangia spherical or pyriform with a membrane which dissolves or fractures easily. Sporangioles with persistent membranes occur very rarely, irregularly arranged along the principal sporangiophore **Mucoraceae**
Sporangial membrane for the most part, cuticularised, persistent and black, or swelling only towards the base; sporangium sometimes simply frees itself leaving the columella, at other times it is thrown off together with the columella and opens only after the swelling of the membrane ..... **Pilobolaceae**
Sporangia of two kinds; one multisporous with a membrane which dissolves, leaving only a naked columella; the other few spored (sporangiole), with persistent membrane, often without columella, caducous. Sporangioles at the ends of branched sporangiophores fixed at regular intervals on the principal sporangiophore ..... **Thamnidiaceae.**

Mucoraceae.

Sporangia pyriform: main sporangiophore often bent to form a rhizoidiferous stolon with the lateral sporangiophores usually borne in small groups along the curved portion: columella rounded, mammiform. Zygospores with suspensors having circinate appendages ABSIDIA

Sporangia spherical.

Sporangiophores fasciculate on a rhizoidiferous stolon, borne on the nodes opposite the rhizoids. Spores often longitudinally striate ..... **RHIZOPUS**

Sporangiophores arising solitary on a mycelium. Spores smooth.

Sporangiophores branched in regular dichasia; zygophores also branched dichotomously.....**SYZYGITES**

Sporangiophores simple or if branched not dichotomously; zygospores borne on the mycelium.

Mycelium often of two kinds, one colourless within the substratum, the other brown and spinescent, aerial; sporangiophores spindle-shaped at the base. Zygospores formed only on the aerial mycelium ..... **SPINELLUS**

Mycelium of one kind only. Zygospores formed on or within the substratum.

Suspensors spinescent. Sporangiophores simple. Mycelium with greenish or olivaceous metallic lustre ..... **PHYCOMYCES**

Suspensors not spinescent. Sporangiophores silky or dull, grey or brown.

Sporangiophores branched sympodially without terminal sporangium, lateral, single or grouped, but always circinate ..... **CIRCINELLA**

Sporangiophores simple or branched but always with terminal sporangium. Sporangium straight, rarely circinate, membrane usually disappearing **MUCOR**

Thamnidiaceae.

Sporangioles borne on circinate sporangiophores **HELICOSTYLUM**

Sporangioles borne on straight sporangiophores.

Lateral branches dichotomous, all terminated by sporangioles ..... **THAMNIDIUM**

Lateral branches verticillate, not usually terminated by sporangioles; stalked sporangioles borne on swellings of the branches ..... **CHAETOSTYLUM**

Pilobolaceae.

Sporangiophore rigid, swollen beneath the sporangium; sporangium forcibly discharged at maturity taking with it the columella ..... **PILOBOLUS**

Sporangiophore of equal size throughout, limp, easily withering; sporangium detaches and leaves columella; not forcibly discharged ..... **PILAIRA**

Mortierellaceae.

Sporangiophore straight, simple or branched, always terminating in a sporangium ..... MORTIERELLA

Conidiophoreae.

Conidia single, spherical or oval, borne by conidiophores which are swollen in the middle or at their extremities; conidiophores sometimes ending in sterile points. Zygospores naked between two straight suspensors
Chaetocladiaceae

Conidia bi- or pluri-cellular, catenulate, fixed on simple or branched conidiophores which terminate in globose heads. Zygospores naked on the summit of pincer-shaped suspensors ..... **Cephalidaceae**

Chaetocladiaceae.

Conidiophores with very many verticillate branches swollen into small heads with sterile prolongations
CHAETOCLADIUM

Cephalidaceae.

Conidiophores dichasially branched, septate at the base of each bifurcation, swollen into terminal heads which bear the chains of conidia and fall with them
PIPTOCEPHALIS

Conidiophores simple or bifurcate, straight or curved, with branched holdfast at the base. Two or several chains of conidia fixed on a basal cell...SYNCEPHALIS

Entomophthorineae.

Usually epizootic in insects, rarely saprophytic or parasitic in plants ..... **Entomophthoraceae**

Entomophthoraceae.

Mycelium endozoic (in insects). Conidia always present. Conidiophore simple. Zygospores unknown. Cystidia and holdfasts absent. Azygospores mostly lateral
EMPUSA

Conidiophores repeatedly branched. Zygospores and azygospores present. Holdfasts developed
ENTOMOPHTHORA

Mycelium purely saprophytic, well-developed, not intercellular. Conidiophores becoming broadly clavate and basidia-like at the apex from which the conidia are cut off
BASIDIOBOLUS

Chytridiineae.

Olpidiaceae.

CHRYSOPHLYCTIS Schilb.
endobiotica Schilb.
OLPIDIUM A. Br.
sphacelarum (Kny) Fisch.
tumaefaciens (Magn.) Berl. et de Toni.
Plumulae (Cohn) Fisch.
endogenum A. Br.
Lemnae (Fisch.) Schroet.
Gillii de Wildem.
ECTROGELLA Zopf
bacillariacearum Zopf
PLEOLPIDIUM Fisch.
cuculus Butl.
irregulare Butl.

Woroninaceae.

WORONINA Cornu
polycystis Cornu

Synchytriaceae.

SYNCHYTRIUM de Bary et Woron.
Taraxaci de By. et Woron.
Succisae de By. et Woron.
Stellariae Fuck.
cupulatum Thomas
aureum Schroet.
Anemones de By. et Woron.
Mercurialis (Lib.) Fuck.

RHIZIDIACEAE.

Rhizophidieae.

RHIZOPHIDIUM Schenk
Eudorinae Hood
Barkerianum (Archer) Fisch.
PHLYCTOCHYTRIUM Schroet.
Westii (Massee) Lemmerm.

Entophlycteae.

ENTOPHLYCTIS Fisch.
helioformis (Dang.).
DIPLOPHLYCTIS Schroet.
intestina (Schenk.) Schroet.

Rhizidieae.

POLYPHAGUS Nowakowski
Euglenae Nowakows.

Cladochytriaceae.

PHYSODERMA Wallr.
Menyanthis de Bary.
graminis (Büsg.) Fisch.
Heleocharidis Schroet.
Comari (Berk. et White) Lagerh.
UROPHLYCTIS Schroet.
Alfalfae (Lagerh.) Magnus.

Ancylistineae.

RESTICULARIA Dang.
nodosa Dang.
Boodlei Fritsch.

MONOBLEPHARIDINEAE.

Monoblepharidaceae.

MONOBLEPHARIS Cornu
sphaerica Cornu

SAPROLEGNIINEAE.

Saprolegniaceae.

SAPROLEGNIA Nees v. Esenb.
ferax Nees v. Esenb.
torulosa de By.
elongata Mass.
LEPTOLEGNIA de Bary
caudata de By.
bandoniensis Swan
ACHLYA Nees v. Esenbeck
apiculata de By.
racemosa Hildebr.
var. stelligera Cornu
polyandra Hildebr.
spinosa de By.
cornuta Arch.
[Americana Humph.]
var. cambrica Trow
APHANOMYCES de Bary
stellatus de Bary
DICTYUCHUS Leitg.
monosporus Leitg.

APLANES de Bary
Braunii de By.

Leptomitaceae.

APODYA Cornu
lacteus (Agardh.) Cornu
APODACHLYA Pringsh.
pyrifera Zopf
brachynema (Hildebr.) Pringsh.

PERONOSPORINEAE.

Pythiaceae.

PYTHIUM Pringsh.
monospermum Pringsh.
proliferum de By.
pythioides (Roze et Cornu).
megalacanthum de By.
de Baryanum Hesse
vexans de By.
intermedium de By.
ultimum Trow
hydnosporum (Mont.) Schroet.

Cystopodaceae.

CYSTOPUS (Lév.) de Bary
candidus (Pers.) de By.
Portulacae (DC.) de By.
Lepigoni de By.
cubicus (Strauss) de By. (=C. Tragopogonis Schroet.), f. spinulosus (de By.).
Bliti (Biv.-Bern.) de By.

Peronosporaceae.

PHYTOPHTHORA de Bary
omnivera de By.
infestans (Mont.) de By.
erythroseptica Pethybr.
BASIDIOPHORA Roze et Cornu
entospora Roze et Cornu
PLASMOPARA Schroet.
pusilla (de By.) Schroet.
nivea (Unger) Schroet.
pygmaea (Unger) Schroet.
densa (Rabenh.) Schroet.
viticola (Berk. et Curt.) Berl. et de Toni
SCLEROSPORA Schroet.
graminicola (Sacc.) Schroet.
BREMIA Regel
Lactucae Regel
PERONOSPORA Corda emend. Schroet.
Holostei Caspary
Arenariae (Berk.) de By.
Dianthi de By.
calotheca de By.
alsinearum Caspary
Myosotidis de By.
Viciae (Berk.) de By.
leptosperma de By.
violacea Berk.
obovata Bonord.
trifoliorum de By.
Radii de By.
Schachtii Fuck.
Violae de By.
Lamii A. Br.
arborescens (Berk.) de By.
sparsa Berk.
affinis Rossmann
candida Fuck.
effusa (Grev.) Rabenh.
Chrysosplenii Fuck.
grisea Unger
Ficariae Tul.
Urticae (Lib.) de By.
Potentillae de By.
var. Gei. Trail
Schleideni Unger.
parasitica (Pers.) Tul.
Hyoscyami de By.
Rumicis Corda
Polygoni Thüm.
sordida Berk.
alta Fuck.
Valerianae Trail

Mucorineae.

Mucoraceae.

MUCOR Micheli emend. Link
rufescens Fisch.

Ramannianus Moell.
Mucedo (Linn.) Bref.
repens (Bain.) Sacc. et Trott.
lausannensis Lend.
racemosus Fres.
erectus Bain.
circinelloides van Tiegh.
plumbeus Bonord.
var. recurvus Grove.
sphaerosporus Hagem.
? succosus Berk.
? lateritius Cooke et Mass.
CIRCINELLA van Tiegh. et Le Monn.
umbellata v. Tiegh. et Le Monn.
simplex van Tiegh.
PHYCOMYCES Kunze
nitens (Agardh) Kunze
SPINELLUS van Tiegh.
fusiger (Link) van Tiegh.
macrocarpus (Corda) Karst.
SYZYGITES Ehrenberg
megalocarpus Ehrenb.
RHIZOPUS Ehrenberg
stolonifer (Ehrenb.) Lind
arrhizus Fisch.
umbellatus A. L. Sm.
ABSIDIA van Tiegh.
glauca Hagem
Orchidis (Vuill.) Hagem

Thamnidiaceae.

THAMNIDIUM Link
elegans Link
verticillatum van Tiegh.
CHAETOSTYLUM van Tiegh. et Le Monn.
Fresenii van Tiegh. et Le Monn.
HELICOSTYLUM Corda
elegans Corda
nigricans van Tiegh.
pyriforme Bain.

Pilobolaceae.

PILAIRA van Tiegh.
anomala (Cesati) Schroet.
dimidiata Grove
PILOBOLBUS Tode
crystallinus (Wiggers) Tode
Kleinii van Tiegh.
var. sphaerospora Grove
longipes van Tiegh.
roridus (Bolt.) Pers.
oedipus Mont.
exiguus Bain.

Mortierellaceae.

MORTIERELLA Coemans
Rostafinskii Bref.
pilulifera van Tiegh.
polycephala Coemans
Candelabrum van Tiegh. et Le Monn.
var. minor Grove
repens A. L. Sm.
[Bainieri Cost.] var. Jenkini A. L. Sm.

Chaetocladiaceae.

CHAETOCLADIUM Fres.
Jonesii (B. et Br.) Fres.
Brefeldii van Tiegh. et Le Monn.

Cephalidaceae.

PIPTOCEPHALIS de Bary
Freseniana de By.
cylindrospora Bain.
SYNCEPHALIS van Tiegh.
intermedia van Tiegh.
Cornu van Tiegh. et Le Mon.

Entomophthorineae.

Entomophthoraceae.

EMPUSA Cohn
Muscae Cohn
Culicis A. Br.
conglomerata Thaxt.
ENTOMOPHTHORA Fres.
aphidis Hoffm.
Pooreana A. L. Sm.
BASIDIOBOLUS Eidam
ranarum Eid.

PROTOMYCETACEAE.

Parasitic in higher plants, with intercellular, septate mycelium. Resting spores (chlamydospores) intercalary in the mycelium or terminal, provided with a more or less thickened membrane. On germination the resting spores give rise to a sporangium (or ascus) with many spores which in most cases copulate in pairs after becoming free.

Resting spores formed in local swellings deep in the tissues of the host: endospores not formed until the sporangium projects from the spore.

Resting spores intercalary with smooth exospore **PROTOMYCES**

Resting spores terminal with warted exospore **PROTOMYCOPSIS**

Resting spores subepidermal in extended coloured patches; endospores formed before the sporangium projects from the spore ..... **TAPHRIDIUM**

PROTOMYCES Unger

macrosporus Ung.
pachydermus Thüm.
rhizobius Trail
? concomitans Berk.

PROTOMYCOPSIS Magnus

Bellidis (Krieg.) Magn.
purpureo-tingens (Mass.).

TAPHRIDIUM Lagerh. et Juel

umbelliferarum (Rostr.) Juel

NOTES ON THE LIST OF BRITISH PHYCOMYCETES.

By J. Ramsbottom.

In preparing the list of British Phycomycetes in the present number of the Transactions several records have been encountered which cannot be regarded as satisfactory. Notes upon these fungi have therefore been gathered here, together with notes on the nomenclature of certain species.

Reesia amoeboides Fisch; Massee Phycomycetes, p. 157.

This species, which was recorded "with a certain amount of doubt," is now usually regarded as being the same as *Olpidium Lemnae* Schroet. The genus *Reesia* was considered by Fisch to differ from *Olpidium* in the fact that its zoospores copulate in pairs on leaving the zoosporangium. This point has not been confirmed, and the genus is sunk by most authors though retained by Schroeter in the Pflanzenfamilien.

RHIZIDIUM. This genus was founded by A. Braun (Monatsb. Berl. Acad., p. 591 (1856) for the species *R. mycophilum.* Fischer in Rabenh. Krypt. Fl. I. iv., p. 121 (1892) took this species out of the genus and proposed a new genus *Rhizophlyctis* to include it and other species of *Rhizidium* which develop outside the matrix of the host. Schroeter (Eng. & Prantl, Pflanzenfam. I. 1, p. 78 (1892)) points this out and uses the name *Phlyctochytrium* as the equivalent of Fischer's genus *Rhizidium* and *Rhizidium* Braun for the single species *R. mycophilum* A. Br. *Rhizidium Westii* (Massee tom. cit., p. 155) becomes therefore *Phlyctochytrium Westii* (Massee) Lemmermann (Abhandl. Naturw. Ver. Bremen., p. 294 (1903)). The other species of *Rhizidium* given in Massee, *R. intestinum* Schenk, is now considered as two distinct species, *Diplophlyctis intestina* Schroet. and *Phlyctochytrium Schenkii* (Dang.) Schroet. As the English record is "on species of *Chara* and *Nitella*" it is listed as *Diplophlyctis intestina.*

ENTOPHLYCTIS HELIOFORMIS (Dang.) nov. comb. This species was described by Dangeard in Bull. Soc. Bot. Fr. XXXIII., p. 356 (1886) and given the name *Chytridium helioformis*, under which name it appears in Massee tom. cit., p. 158. In

Journ. de Bot. ii., p. 143 (1888). Dangeard re-describes and figures the species, but changes the name to *C. heliomorphum*, Fischer in Rabenh. Krypt. Fl. I. iv., p. 118 (1892) placing the species in his new genus *Entophlyctis*, adopts the later specific name. The earlier specific name must be used no matter what the genus in which the fungus is placed.

Physoderma Comari (Berk. et White) Lagerh. This species was described by Berkeley and White (Ann. Mag. Nat. Hist. Ser. 5, I., p. 27 (1878)) under the name *Protomyces Comari*. It has usually been included in *Protomyces Menyanthis* though "the pustules are far more prominent." De Toni and Massee in Journ. Mycol. IV., p. 18 (1888) have a description of "*Doassansia Comari* (Berk. et Br.), De Ton. et Massee in Herb. Kewensi; *Protomyces Comari* Berk. et Broome in Ann. Nat. Hist., No. 1708." The number and the locality ("pr. Forfar Britanniae") show that this is supposed to be Berkeley and White's species. The spores are described "sporis late ellipticis, $10 \times 7\mu$, levibus," whereas the original description says "spores ·001-·0012 inch long, broadly obovate." The type specimen in the Kew herbarium shows spores even exceeding the latter measurement. There does not appear to be anything resembling a *Doassansia* on the *Comarum* from Loch of Kinordy, Forfarshire, collected by M. Anderson. (*Doassansia Comari* De Toni & Mass. is also given in Massee's Mildews, Rusts and Smuts, 1913, p. 201.) Lagerheim (Bih. K. Svensk. Vet. Akad. Handb. XXIV., iii. 4, p. 11 (1898)) places *P. Comari* Berk. et White in the genus *Physoderma*. He describes the spores as round or ellipsoid, 25-40μ, with smooth, rather thin membrane and colourless oily contents. Some of the spores in the type specimen reach up to 50μ.

Pythium hydnosporum (Mont.) Schroet. This species is usually written as *Pythium Artotrogus* de Bary. The conidial form of the fungus is not at present known, but in spite of that it is customary to place it in the genus *Pythium*. Montagne (Gard. Chron. 1845, p. 640) gave the name *Artotrogus hydnosporus* to the oosporic stage of the fungus, and this specific name must be retained. The question whether *Artotrogus* being the name of the perfect stage of the fungus should replace some well established name such as *Pythium*, is one that can well be left until something more is known of the life history of the fungus in question. Fortunately the principle of Nomina conservanda has been accepted by the International Botanical Congresses.*

* The list of fungus generic names to be conserved was to have been considered at the London Congress, 1915.

PYTHIUM PYTHIOIDES (Roze et Cornu) nov. comb. Roze and Cornu (Ann. Sci. Nat. 5 ser. XI., p. 84 (1869)) described a new genus and species, *Cystosiphon pythioides*. The genus *Cystosiphon* they regarded as intermediate between the Saprolegniineae and Peronosporineae, but apparently considered that the fungus could not be a species of *Pythium*, because it was parasitic on a phanerogam! Lindstedt (Syn. Saprolegniaceae 1872, p. 50) placed the fungus in the genus *Pythium* and gave it the name *P. Cystosiphon*. As the earliest specific name must be adopted, the fungus must be called *Pythium pythioides:* unfortunately there is no nomenclatural rule against such illogical combinations.

P. incertum Renny. This does not seem to have been described by Renny, though W. G. Smith gives an unsatisfactory figure of it in Gard. Chron. VI., p. 11 (1876).

Aplanes androgynus (Arch.) Humphrey, Saprol. of U.S., p. 134 (1893).

Saprolegnia androgyna Archer in Quart. Journ. Micros. Soc. VII., p. 123 (1867).

? Aplanes Braunii Reinsch in Jahr. Wiss. Bot. XI., p. 284 (1877).

A. Braunii de Bary in Bot. Zeit. XLVI., p. 650 (1888).

Saprolegnia mucophaga W. G. Sm. in Gard. Chron. XX., p. 781 (1883). The description and the figure are both unsatisfactory. Humphrey Tom. cit., p. 112, suggests that this and the next species may belong to the genus *Pythium*.

S. philomukes W. G. Sm. in Diseases of Field and Garden Crops, 1884, p. 67. (See also Gard. Chron. XXII., p. 245 (1884).) The descriptions and figures given of this fungus are not such as would enable it to be identified if again met with.

S. corcagiensis Hartog, Quart. Journ. Microscop. Sci. XXVII., p. 429 (1887) is probably *Apodya lactea*. Following Fischer (Rabenh. Krypt. Fl. Pilze I., 4 (1892), pp. 370, 372) the name *Apodya* Cornu has been adopted instead of the more usual *Leptomitus* Agardh. As Fischer points out, Agardh used the name for a whole host of different organisms from which *L. lacteus* was taken out by Pringsheim and others as being a species of *Saprolegnia*. Cornu made it the type of his genus *Apodya* (Ann. Sci. Nat. 5 ser. XV., p. 14 (1872)). The other species that could be identified had already been removed to *Saprolegnia* by Kützing in 1843. The fact that this species was the only clearly defined one left of the old genus *Leptomitus* cannot decide against the adoption of Cornu's generic name.

Ostracoblabe implexa Born. et Flah. was recorded as British

from specimens found at Clare Island (see Trans. Brit. Mycol. Soc. IV., p. 165 (1913)). Bornet and Flahault in their original investigations regarded it as a member of the Saprolegniaceae (Bull. Soc. Bot. Fr. XXXVI., p. CL. (1889)), but later Bornet (Journ. de Bot. V., p. 397 (1891)) made further investigations upon it and decided that the filaments described are really the hyphae of the lichen *Verrucaria consequens* Nyl., which are capable of living in an independent condition as well as in association with the algae, *Mastigocoleus testarum* and *Hyella caespitosa*. "L'exposition à l'air libre pendant un temps assez long paraît être la condition nécessaire à la formation du thalle complet. Quand les coquilles se trouvent à une trop grande profondeur, le Lichen parfait ne se developpe pas."

CYSTOPUS. The present writer has shown (Journ. Bot. LIV., p. 76 (1916)) that the generic name *Cystopus* is to be used in preference to the name *Albugo*, as the latter is pre-Friesian, and *Cystopus* is also the name applied by de Bary to the oosporic stage. The names given by de Bary should be regarded as the starting point for the nomenclature of the species.

The species described by de Bary as *Cystopus spinulosus* is regarded by most authors as being the same as *C. cubicus* (Strauss) de Bary (=*C. Tragopogonis* Schroet.). De Bary himself, when describing the species (Ann. Sci. Nat. 4 ser. XX., p. 133 (1863)) was not very certain as to the specific difference, and stated that only culture experiments could decide. The fungus is found on *Carduus* spp. and does not show the same variation in the oosporic membrane as does the typical *C. cubicus*. In the list it is given the rank of a *forma*:—*Cystopus cubicus* (Strauss) de Bary f. *spinulosus* (de Bary).

ENDODROMIA. This genus was proposed by Berkeley in Hook. Journ. III., p. 79 (1841). "Peridium very delicate, bursting when immersed in water, and soon breaking up into little granular portions, filled with globose colourless sporidia and radiating branched threads of extreme delicacy. Within each sporidium is a single globose nucleus which moves about within its cells with the greatest activity, from which circumstance I have framed the generic name. . . . . The genus is evidently a higher development of *Mucor*, and seems to be an anticipation of *Stemonitis*." There is no specimen in Berkeley's herbarium at Kew, so one has only the description and an unsatisfactory drawing to go upon. Miss Lister (Mycetozoa, 1911, p. 170) states that it appears possible that it is the same species as *Heimerlia hyalina* v. Höhn (Ann. Myc. I., p. 391 (1903)) which some have classed with the Mycetozoa, but which does not appear to belong to the group. There can

be no real certainty about Berkeley's genus, and it would probably be the best policy to totally disregard it.

Mucor mucedo L. var. *caninus* Mass. (Mass. l.c., p. 87) and *M. stercoreus* Link (p. 88) are both included under *M. mucedo* in the list.

M. subtilissimus Berk. (Hort. Journ. III., p. 98 (1848)) and *M. tenerrimus* Berk. (Hook. Journ. Bot. III., p. 78 (1841)) are not apparently represented in Berkeley's herbarium, and cannot possibly be identified from the drawings and descriptions. The drawing of the latter (*Hydrophora tenerrima* l.c., t. 1, f. B) does not appear to represent a fungus.

M. amethysteus Berk. (Eng. Fl. V., p. 332 (1836)) is not represented in Berkeley's herbarium. The description is insufficient for purposes of re-identification. There is a specimen in Broome's herbarium at the British Museum which is in a very poor condition but may be *Rhizopus stolonifer*.

M. hyalinus Cooke Handb. II., p. 632 (1871). An examination of various specimens on leaves of *Buxus*, named by Cooke, has not disclosed any member of the Phycomycetes. It has been considered advisable, therefore, to follow the example of most writers and disregard the species.

M. pruinosus B. et Br. (Ann. Mag. Nat. Hist. 4 ser. XV., p. 40, No. 1495 (1875)). The specimens in Berkeley's herbarium and in Broome's herbarium are on broken up soil. It is impossible to find the fungus. The description of the species is too meagre for any identification.

M. lateritius Cooke et Massee in Grev. XVII., p. 3 (1888). Concerning this species Massee says (p. 88): "The present species is not a good *Mucor*, neither does it agree in all points with any described genus, but until something is known of the sexual stage it is not advisable to remove it from the genus under which it was originally described. Some features suggest an affinity with *Sporodinia*."†

Mucor plumbeus Bonord in Abt. naturf. Ges. Halle VII., p. 109 (1864).

M. spinosus van Tiegh.* in Ann. Sci. Nat. 6 ser. IV., p. 390 (1876).

Mucor repens (Bain.) Sacc. et Trott. in Sacc. Syll. Fung. XXI., p. 821 (1912).

Glomerula repens Bainier in Bull. Soc. Mycol. Fr. XIX., p. 154 (1903).

Mucor Glomerula Lendner, Mucorin. Suisse, p. 69 (1908).

† *M. lateritius* Link Sp. Plant. VI. 1, p. 84 (1824) is probably *Eurotium herbariorum* Link.

* *M. spinosus* Schrank in Denksch. Münchener Akad. Wissensch., p. 14 (1813) is a species of *Achlya*.

SYZYGITES. The present writer has shown (Journ. Bot. LIII., p. 303 (1915)) that as *Syzygites megalocarpus* Ehrenb. was the name given to the perfect stage (zygospore) of the fungus recently more usually called *Sporodinia grandis* Link, it should be adopted. Both names were used by Fries in his *Systema*, as he was unaware of the connection between the sexual and asexual stages.

Rhizopus stolonifer Lind. This species was first described under the name *Mucor stolonifer* by Ehrenberg (Sylvae myc. Berol. p. 25 (1818)). Ehrenberg in Nova Act. Acad. Leop. X, p. 198 (1820) gives a long description of the fungus (with a coloured plate) under the name *Rhizopus nigricans*—"Rhizopus noster a Mucoribus genere differt ob opertas radices (novam partem) et fructus fasciculatos." Fries in Systema III., p. 321 (1832) adopts the name *Mucor stolonifer*. De Bary first described the zygospores (Beit. Morph. n. Physiol. der Pilze II., p. 25 (1866)) and used the same name. The specific name "stolonifer" must therefore be used, according to the Rules, and we get thus a name—*Rhizopus stolonifer*—which is a combination made up of Ehrenberg's two names for the fungus!

PROTOMYCOPSIS PURPUREO-TINGENS nov. comb.

The species described by Massee (p. 164) as *Protomyces purpureo-tingens* has been placed in the genus *Protomycopsis* in the list. The chlamydospores have a warted exospore, and from the figure given (pl. 5, f. 73) they are apparently terminal, as the description—"often with a short persistent portion of the mycelium"—would seem to infer. I have not been able to examine a specimen.

Of the other species of *Protomyces* given in Massee's book, *Protomyces Menyanthis* de Bary is listed as *Physoderma Menyanthis* de Bary; *Protomyces Ari* Cooke is *Melanotaenium Ari* (Cke.) Lagerh.

SOME NOTES ON THE HISTORY OF THE CLASSIFICATION OF THE PHYCOMYCETES.

By J. Ramsbottom, M.A., F.L.S.

Having regard to the prevalence of decay brought about by fungi it is certain that moulds must have been known through all time. It is remarkable therefore that the old natural historians such as Theophrastus and Pliny apparently made no mention of such common objects as mouldy bread, though the latter remarks upon the mustiness of wine. Columella, a landed proprietor and agricultural author of about the middle of the first century, mentions the down which develops on bread, flesh and wine in moist places; he also states that food should be kept in a very dry place so that it will not develop *mucor*.

At the outset we meet with a difficulty in the use of the word mould. The term is applied in popular language to any microscopic saprophytic fungus appearing woolly or furry to the naked eye and attacking provisions or other substances of domestic interest; and though the name is often restricted to Zygomycetes by botanists there is an equally common use of the word to include also the Hyphomycetes. We can be certain that where mouldy bread is mentioned, the fungi generally causing the trouble are *Mucor*, *Penicillium* and *Eurotium*. We read of such bread in the book of Joshua in the account given of the successful attempt of the inhabitants of Gibeon to deceive him into believing them to have come from a great distance, for working wilily, one of their tricks was to make certain that "all the bread of their provision was dry and mouldy"; and this was pointed out to Joshua:—"This our bread we took hot for our provision out of our houses on the day we came forth to go unto you; but now, behold, it is dry, and it is mouldy." We find in early English (1460-1470)*:—"Thou lettest poore men go bare, thy drynkis soweren, thou mouledest metis where-with the febull myght wele fare," and in Palsgrave (1530):—"It is tyme to eate this breed, for it begynneth to mowlde."

* *Cf.* Political, Religious and Love Poems, Lambeth MS. ed. F. T. Furnivall.

The first reference to moulds in scientific works appears in Robert Hooke's Micrographia or Some physiological descriptions of minute bodies made by magnifying glasses with observations and inquiries thereupon—published in 1665. The author of these "studies of quiet and retirement" was one of the most interesting and able of scientists. Born in 1635 he was so weak that he was unable to undergo the usual course of studies for the Church. Left to himself he sought diversion in constructing mechanical toys, amongst which was a clock which "would go" and a model of a ship "with a contrivance to make it fire off some small guns, as it was sailing across a haven of a pretty breadth." Afterwards, on going to Westminster school, he astonished his teachers by mastering six books of Euclid in a week. It is added that he did besides, of his own accord, learn to play twenty lessons on the organ and invented thirty several ways of flying. In 1653 he went to Oxford, and later became associated with the celebrated Robert Boyle as his assistant. In 1662 he was made curator of experiments to the Royal Society when Boyle was thanked for dispensing with his services: he became secretary to the society in 1677. His mind was so prolific that there was scarcely a discovery made in his life-time that he did not conceive himself entitled to claim. In person, we are told, he was despicable, being crooked of stature, and as he grew older, more and more deformed. Pepys thought "his discourse in general mighty fine" but his pretensions "to tell how many strokes a fly makes with her wings a little too much refined." His Micrographia is full of ideas and ingenious anticipations. In his studies he "made use of Microscopes, and some other Glasses and Instruments that improve the sense." We are expressly told that the glasses used were "of our English make." He gives a full description of the method of making and using his microscope, and tells us that "both microscopes and telescopes as they now are will magnify an object about a thousand thousand times bigger than it appears to the naked eye." "By the help of microscopes, there is nothing so small, as to escape our inquiry. . . . By this the Earth it self, which lyes so neer us, under our feet, shews quite a new thing to us, and in every little particle of its matter, we now behold almost as great a variety of Creatures, as we were before able to reckon up in the whole Universe itself." Two sections† relate to Fungi. Observ. XIX. "Of a Plant grow-

† Since it is very apt to be overlooked as it occurs in the observation (XXII) on sponges and spongy fibrous bodies, it is perhaps worth while to call attention to what is probably the first anatomical account of fungus structure:— "Having examin'd also several kinds of Mushrooms, I finde their texture to

ing in the blighted or yellow specks of Damask-rose-leaves, Bramble-leaves, and some other kind of leaves," in which is given an account of *Phragmidium:* and Observ. XX. "Of blue Mould, and of the first Principles of Vegetation arising from Putrefaction." The account given in this first study of microscopic moulds is interesting. "The Blue and White and several kinds of hairy mouldy spots, which are observable upon divers kinds of *putrify'd* bodies, whether Animal substances, or Vegetable, such as the skin, raw or dress'd, flesh, bloud, humours, milk, green Cheese, etc., on rotten sappy Wood, or Herbs, Leaves, Barks, Roots, etc. of Plants, are all of them nothing else but several kinds of small and variously figur'd Mushrooms, which, from convenient materials in those *putrefying* bodies, are, by the concurrent heat of the Air, excited to a certain kind of vegetation, which will not be unworthy our more serious speculation and examination, as I shall by and by shew. . . . The whole substance of these pretty bodies was of a very tender constitution, much like the substance of the softer kind of common white Mushrooms, for by touching them with a Pin, I found them to be brused and torn; they seem'd each of them to have a distinct root of their own; for though they were neer together in a cluster yet I could perceive each stem to rise out of a distinct part . . . ; some of these were small and short, as seeming to have been but newly sprung up, of these the balls were for the most part round, others were bigger, and taller, as being perhaps of a longer growth, and of these, for the most part, the heads were broken, and some

be somewhat of this kind, that is, to consist of an infinite company of small filaments, every way contex'd and woven together, so as to make a kind of cloth, and more particularly, examining a piece of Touch-wood (which is a kind of *Jews-ear,* or Mushroom, growing here in *England* also, on several sorts of Trees, such as Elders, Maples, Willows, etc. and is commonly call'd by the name of *Spunk*;‡ but that we meet with to be sold in Shops, is brought from beyond Seas) I found it to be made of an exceeding delicate texture: For the substance of it feels, and looks to the naked eye, and may be stretch'd any way, exactly like a very fine piece of *Chamois* Leather, or wash'd Leather, but it is of somewhat a browner hew, and nothing neer so strong; but examining it with my *Microscope,* I found it of somewhat another make than any kind of Leather; . . . The texture of this Touch-wood seems more like that of a Lock or a Fleece of Wool, for it consists of an infinite number of small filaments. . . . The filaments I could plainly enough perceive to be even, round, cylindrical, transparent bodies, and to cross each other every way, that is, there were not more seem'd to be *horizontally* than *perpendicularly* and thwartway, so that it is somewhat difficult to conceive how they should grow in that manner. By tearing off a small piece of it, and looking on the ragged edge, I could among several of those *fibres* perceive small joints, that is, one of those hairs split into two, each of the same bigness with the other out of which they seem'd to grow, but having not lately had an opportunity of examining their manner of growth, I cannot positively affirm any thing of them."

‡ Amadou—*Fomes fomentarius.*

much wasted; what these heads contain'd I could not perceive; whether they were knobs and flowers, or seed cases, I am not able to say, but they seem'd most likely to be of the same nature with those that grow on Mushrooms, which they did, some of them, not a little resemble. Both their smell and taste, which are active enough to make a sensible impression upon those organs, are unpleasant and noisome." By passing some of the growing fungus three or four times through the flame of a candle Hooke found that they were not so quickly destroyed as at first sight he conceived they would be "so that, it seems they are not very apt to take fire, no more than the common Mushrooms are when they are sappy." He had difficulty with regard to the reproduction of fungi but gave an explanation of their origin which savours of his period. "First, that Mould and Mushrooms require no seminal property, but the former may be produc'd at any time from any kind of putrifying Animal, or Vegetable Substance, as flesh, etc., kept moist and warm. . . . Next, that as Mushrooms may be generated without seed, so does it not appear that they have any such thing as seed in any part of them; for having considered several kinds of them, I could never find any thing in them that I could with any probability ghess to be the seed of it, so that it does not yet appear (that I know of) that Mushrooms may be generated from a seed, but they rather seem to depend merely upon a convenient constitution of the matter out of which they are made, and a concurrence of either natural or artificial heat." Hooke mentions the multitude and other shapes of these "Microscopical Mushrooms," which would take a long work to describe. The figure he gives of the fungus concerning which he chiefly writes, as also his description, seems to refer to some species of *Mucor*.*

I have devoted considerable space to Hooke's observations because he was the first to use the microscope to investigate fungi. It would be an interesting study to trace out the relation between botanical discoveries and the improvement in microscopes from their introduction. Hooke lived in the classical period of microscopy when the invention of lenses of very short focus made the simple microscope a valuable means of research. Matters had then advanced much from the time of Seneca, who had written that "Letters, however small and dim, are comparatively large and distinct when seen through a glass globe filled with water." It does not appear that the

* This figure is copied in Sterbeeck's Theatrum Fungorum (1675), Pl. 31. The description there given is essentially the same as that of Hooke. Miss A. Lorrain Smith in her Presidential Address (Trans. Brit. Mycol. Soc. III. (1908) reproduces Hooke's figure.

ancients had either concave or convex lenses, though they knew of the properties of curved reflecting surfaces. The first who is known to have used lenses, and who can therefore be regarded as the inventor of the simple microscope, was the much misunderstood philosopher Roger Bacon (1214?—1294), whose Opus Major has been described as "at once the Encyclopaedia and the Organon of the thirteenth century."† It was not until about three hundred years afterwards that use was made of the simple microscope. Telescopes were invented in Holland about the year 1608. It would seem that the compound microscope was invented by the famous astronomer and scientist Galileo Galilei probably in the year 1610. This was a small Dutch telescope with two lenses, one convex and one concave, and not a reduced Kepplerian telescope like that invented by Drebbel in 1621. In letters written by his friends we read: "Galileo told me he had invented an occhiale [telescope] which magnifies things as much as fifty thousand times [i.e., about thirty-six diameters] so that one sees a fly as large as a hen": also "The instrument was of no greater height than an ordinary dining-room table." It was the discovery by various observers that lenses could be combined into telescope and microscope that gave the first stimulus to investigation. Galileo was a member of the famous Accademia dei Lincei§ (1603-1630) which gathered round the brilliant and short-lived Federigo Cesi, Duke of Aquasparta. The academy had as a device a lynx with upturned eyes tearing a Cerberus with its claws. Amongst the members were the famous G. della Porta, who invented the camera obscura, Fabio Colonna the botanist, Francesco Stellato, scholar and naturalist, Francisco Fontana the astronomer, and Johannes Faber, physician to Pope Urban VIII. The latter, writing to Cesi in 1625, says concerning Galileo's instrument:—"As I also mention his new *occhiale* to look at small things and call it microscope, let your Excellency see if you would like to add that, as the Lyceum gave to the first the name of telescope, so they have wished to give a convenient name to this also, and rightly so because they are the first in Rome who had one." Faber used the name in a work published in 1628 and gives what is doubtless the first statement on botanical microscopy. "Our prince Cesi commissioned an artist, specially chosen for the work, to make draughts for him of numerous plants hitherto regarded by

† The invention of spectacles is attributed to Salvino d' Amarto degli Armati, a Florentine, about the year 1300, and the discovery was made known to the world by Alessandro de Spina, a monk of Pisa.

§ The Acadamy was resuscitated in 1870 with the title Reale Accademia dei Lincei, with a literary as well as a scientific side.

botanists as seedless, but clearly revealed by this instrument, the Microscope, to be teeming with seeds. Such is the wonderful and minutely fine dust adherent to the back of *Polypodium* leaves, and appearing as big as peppercorns, but till then reckoned as Nature's mere ornament. These very objects indeed, the Prince, even before using the Microscope, had already designated as seeds, and on that account had set down the plants in the class of 'Tergifoetae.' And when in due course his books and studies of plants shall see the light, we shall possess numberless other novel observations of the Prince."

One of the founders of microscopical research was the Italian, M. Malpighi, who shares with Nehemiah Grew the credit of founding the study of plant anatomy.* Born in 1628 he first studied medicine and anatomy. One of his first researches was the investigation of the circulation of the blood by means of the microscope. He acquired much fame and was elected foreign member of the Royal Society which afterwards "testified their regard for him by printing his works at its own expense." Being elected physician to Pope Innocent XII. he spent the last years of his life apart from his former pursuits: perhaps the fact that all his pictures, furniture, books and manuscripts had been destroyed at the burning of his house by the negligence of his old wife made the change of pursuits somewhat easier for him. In his Opera omnia there is a section De plantis quae in aliis vegetant (1686) which treats of Fungi along with Mistletoe, Lichens, Mosses, etc. The fungi are for the most part microscopic, and a plate illustrating them is given. Malpighi states that the nature of "Mucedo" has been hitherto obscure on account of its small size and the various forms which it assumes almost escaping the sharpness of the senses and of the mind. His first species was found covering the whole exterior surface of some cheese which was not of the best quality, as it were a great forest. It is possibly *Mucor mucedo*. The appearance of the sporangia at different stages is described and, naturally, the resemblances to a flower (and also to the leaves of a moss) are pointed out. The second species figured and described is almost without

* Concerning this it is interesting to note that Pierre Borel issued a work on the telescope in 1655, and appended to it is a series of one hundred microscopic observations, mainly on minute insects. "Some of Borel's most remarkable observations were made on plant anatomy, and have been unaccountably passed over. He saw minute markings on young leaves which were probably outlines of cells, and he has one passage that apparently describes the movement of protoplasm, an observation which preceded that of Corti on *Chara* by more than 100 years. He appears to have seen the stomata on leaves, and to have fully realised their power of opening and closing. He followed up Cesi's observations on the fronds of fern and saw the spores."

doubt *Rhizopus stolonifer*—with its sporangia, groups of five, three or two sporangiophores arising from a common node, and its stolons and holdfasts. This species occurred on the putrescent pericarp of *Cucurbita*. Other microscopic fungi are described from lemons, oranges, wood and bread. These are Hyphomycetes (e.g., *Botrytis*), and in these Malpighi clearly figures the spores. The sporangiophore is interpreted as being an inflorescence with the spores as florets. He also figures what are apparently septate mycelia, and describes the burst sporangium of one of his species of Mucedo. After remarking on the fact that the plants treated in the section derive nutriment from their host plants and that Mistletoe is propagated by seeds, he states that it is unknown how the others arise and multiply, especially Fungi and Mucedo. He has observed mycelia growing upon wood, and holds that the plants must be propagated by their own seed or by fragments of themselves, probably distributed by wind. Thus Malpighi favours the theory of an origin from seed, whereas Hooke holds for spontaneous generation.

Two years later John Ray, in his Historia Plantarum (1688), published a catalogue of plants observed in Virginea by John Banister, "eruditissimus vir et consummatissimus Botanicus." In it there appears the first description of *Pilobolus*. It had been found growing on fresh horse dung, arising in a night; the small drops of water crowning the sporangiophore are mentioned and the sporangium is described as a small black spot like the eye of a Limax. Plukenet figures in his Phytographia what he regards as Banister's fungus. The illustration probably refers to *P. roridus* and is perhaps the fungus mentioned by Petiver in the appendix to the second edition of Ray's Synopsis (1696) where "Mr. Banister's Virginea mushroom with dewy heads" is recorded as British. "This I have observed on Horse-dung about London." Four other species which are apparently *Mucor*, and its allies, are also included. Petiver has the same figure as Plukenet, and also two other figures in his Gazophyalcium which seem to be moulds:—"Pin-headed Cobweb Mushroom: Dr. Charles Goodall, President of the College of Physicians, sent me this, which he observ'd to spring from *Flower* and *Water* putrefied," and "Pin-headed pendant Mushroom: This grew on the under side of a Rose Leaf, and was presented me by the curious Mr. Joseph Dandridge."†

† The fungi described by Richard Bradley in 1716, "Some Microscopical Observations, and Curious Remarks on the Vegetation, and exceeding quick Propagation of Moldiness, on the Substance of a Melon" do not appear to be Mucorineae.

We owe the foundation of the genus *Mucor* to the Florentine botanist P. A. Micheli.* The more one studies the older works which deal with fungi the more one realises what an enormous influence this botanist had upon the subject. Taking merely generic names, *Aspergillus*, *Botrytis*, *Clavaria*, *Geaster*, *Lycogala*, *Mucor*, *Phallus*, and *Polyporus* were proposed by him, and are used with practically the significance he gave them. He was the first to apply the microscope systematically to the study of the group. Micheli divides fungi into four divisions, the two first having "apetalous flowers." The thrd division is characterised by having its seeds on the surface, whereas those of the fourth division are enclosed: *Botrytis*, *Byssus*, *Aspergillus* and *Clavaria* are included in the former, whereas *Mucor* is placed in the latter together with *Clathrus*, *Lycogala*, *Lycoperdon*, and *Geaster*. Figures are given of the species of *Mucor* and Micheli describes the bursting of the sporangium with its single cavity, the columella and the spores. He divides the species into those with a pedicel and those without. Each section contains two species (*Mucor vulgaris* etc. = *M. mucedo*, *M. albus* etc. = *Dictyostelium mucoroides; Mucor globosis* etc. and *M. minimus* etc.) Micheli was the first to attempt to reproduce fungi from spores using for this purpose *Agaricus* spp., *Mucor*, *Botrytis* and *Aspergillus*. He describes his experiments which he performed in 1718. In one experiment he collected spores from the sporangia of *Mucor* with a soft brush, and smeared them on to the surface of a piece of melon, which he placed where it was not exposed to wind or sun. After five days a white mycelium appeared on the infected surface of the melon, and by the tenth day ripe sporangia of *Mucor* were present. In another experiment he used the spores thus produced and smeared one side of a piece of melon with them, placing spores of *Aspergillus* on the other surface of the slice. Growth occurred as before, and both plants produced seed after their kind. The spores from these crops were used in several repetitions of the experiment with no observable difference in the results. Other experiments are recorded, in one of which *Mucor* appeared, "no one having planted it, but the seeds having fallen there by chance"; and in another, at the end of the experiment *Botrytis* and *Aspergillus* appeared, not having been sown there, and the same explanation is given. Micheli's experiments did not receive the attention they deserved and many writers were not inclined to accept his results. The question was as Hooke had stated it, moulds either arose from spores or by spontaneous generation.

* The remains of the herbarium of Micheli are now in the Botanical Institute of Florence.

The problem of the origin of life is one that has interested all ages. The Greek philosopher Thales considered that life originated in water.* Aristotle held that insects bred from putrefaction and eels and certain fishes from the mud of rivers: further, dry bodies engendered animals when they became damp, and moist bodies when they became dry. Van Helmont (1577-1644), the famous chemist and physicist, was a great believer in spontaneous generation, stating that even mice could be generated by placing dirty linen in a receptacle together with a piece of cheese or a few grains of wheat.*

Together with the belief in spontaneous generation there often occurred a belief in transmutation, *e.g.*, Francis Bacon, who believed that insects bred from decaying matter also believed that oak boughs stuck into the earth produced vines.‡ The first real blow struck at these ideas was by Redi (1668), who by taking the precaution of covering with wire gauze the mouth of a bottle in which he had placed meat, showed that the larvae of blow-flies were not formed spontaneously during decomposition. Valisneri provided a similar demonstration for fruit grubs, and Swammerdam, Leeuwenhoek and Réaumur gave the finishing touches. But with the introduction of the microscope the theory became more refined, and it was now over the animaculae and microscopic eels which everyone could observe in various liquids kept enclosed for a day or two that the controversy became vigorous. Needham, an English cleric, and the French naturalist Buffon, were now the chief upholders of the theory, and held that a productive or vegetative force existed which was responsible for the production of organized beings. Needham attempted to sterilize putrescible organic matter by enclosing it in vessels which he placed in hot ashes: but later he found animaculae in the fluids where none had been previously observed. The theory in this form was refuted by the work of Spallanzani. Later (1858) it was again put forward by Pouchet, which led to the work of Pasteur, who destroyed the theory with regard to bacteria. The controversy has now entered the domain of biological chemistry.

* Van Helmont's recipe for producing scorpions is as follows:—" Scoop out a hole in a brick. Put into it some sweet basil, crushed. Lay a second brick upon the first so that the hole may be perfectly covered. Expose the two bricks to the sun, and at the end of a few days the smell of the sweet basil, acting as a ferment, will change the herb into real scorpions." An even more startling account is that given by Buonanni who stated that some rotten timber which he rescued from the sea produced worms which engendered butterflies which in their turn became birds.

‡ *Cf.* also Nat. Hist. §339 (1626), " All Moulds are Inceptions of Putrefaction; As the Moulds of Pyes and Flesh."

The Abbé Lazardo Spallanzani (1729-1799) was educated at the University of Bologna, where his famous kinswoman, Laura Bassi, was professor of physics. In 1754 he became professor of Logic, Metaphysics and Greek in the university of Reggio, and later was transferred to Modena He devoted the whole of his leisure time to Natural Science. In 1768 he accepted the invitation of Maria Theresa to the chair of Natural History in the University of Pavia, which was then being reorganized. He became director of the museum. His lectures were so popular that his students exceeded five hundred in number in one year.

Spallanzani (1777) investigated the question as to whether moulds grow from seeds. "It is universally received, that the origin of every plant must be from some part of another plant; and it was probably the inability to discover that part, or to recognise the seeds, that allowed the belief of spontaneous generation." Monti, Professor of Natural History at Bologna, had repeated Micheli's experiments without finding them conclusive, vegetative substances being equally covered with mould whether spores were placed upon them or not. This had "led some people into the dangerous theory of spontaneous generation." The mould† used by Spallanzani in his experiments is obviously *Rhizopus stolonifer*, growing on moistened bread and decaying fruits. Seeing the columella under the microscope he remarks that the heads "are shaped like mushrooms, or, to speak more philosophically, they are real mushrooms," and a little exaggeration in his figures makes the point more obvious. He points out that the origin and increase of mould is nearly in proportion to the heat of the atmosphere, and mentions how much better growth is under a receiver, owing to the lack of oscillation caused by draughts, and the greater humidity. In one experiment two pieces of moistened bread as similar as possible were taken, and one piece was strewn with the spores of the mould, while the other was untouched. The inoculated piece had some mould upon it the next day, the other none. Before the third day both pieces were covered with mould, but the sown piece had almost double the quantity; the species being the same in both cases. The experiment was repeated eleven times and the same result was obtained. Similar experiments tried with various fruits gave practically the same result. He concludes that sowing the spores accelerates the production of mould, increases the thickness, and lessens the height (owing to crowding). Another

† A second species I cannot identify from his figure: "a kind of mould sometimes grows on pears, which is actually a shrub in miniature, universally adorned with spherical heads and mushrooms."

proof that the "dust" is the "seed" is seen from the fact that more abundant production arises from scattering it. Other experiments were made which supported the theory. He also tried to germinate spores on objects such as glass, stones, metals, writing paper. "All the substances were kept moist; but no traces appeared except some filaments which were perceptible on sponge. Certain substances are requisite for the expansion of the seeds, and these are found only in particular substances." According to Spallanzani the spores of mould can resist a degree of heat which no other seeds can support without losing the power of germination, which would account for Monti's statement that substances become mouldy even after boiling. He remarks upon the large number of spores in each sporangium and the immense number of sporangia in each spot of mould. "The seeds of mould may be disseminated in such abundance as to enter into the composition of all animal and vegetable substances . . . it is the readiest method of accounting for the extraordinary abundance and universal existence of mould . . . one of the most reasonable hypotheses in philosophy."* He apparently encountered a large number of genera, as he says, "to describe the prodigious variety of mould would require a volume: it would be a methodical system of botany." He does not think they all ought to be classed as fungi. "I have seen several species which rather appeared to belong to grasses: and oftener than once, I have thought flowers were perceptible." He thinks it appears indisputable that some species belong to genera of plants whose larger species are well known. Concerning Cryptogams, he says they formed "an immense pit into which every plant of obscure origin, little known, or imperfectly described, was thrown."

In Spallanzani we find an early reference to the Saprolegniaceae. "When a minnow or a leech dies under water,

* C. Bonnet (1720-1793), who was a correspondent of Spallanzani, wrote to him saying: "Your experiments on mould have excited my attention very much. When the vegetation of these minute plants ceases, in vessels hermetically sealed and exposed to the action of heat, it is more than probable that the numbers which appeared on vegetable substances that had boiled for half an hour to two hours, came from the ambiant air. The seeds must be of such extreme minuteness that we cannot wonder if they penetrate wherever air has access." Later on in the same letter he writes: "I wish a society of botanists would engage in the study of these plants alone. What do I say, '*mould*' only would demand their whole attention. Nothing is better adapted to make us forcibly feel the narrow limits of our corporal and mental abilities than applying to researches on the most minute productions of Nature. All the finest faculties seem to vanish at the root of a stalk of mould." It is not likely that Bonnet himself conducted any experiments on mould. After having discovered parthenogenesis in aphids at the age of twenty, his eyes failed, and he then took up philosophy.

even several inches from the surface, and has seldom or never come there but for the purpose of respiration, it will soon be covered with a peculiar kind of long slender mould, while lying at the bottom, as I have repeatedly seen. Various species, some slender, some thicker, others more bushy and slender, grow on different animal or vegetable substances also under water: it then seems more luxuriant, which is a general remark to be made of mould where it imbibes most nutriment. Whence does this mould originate?" He queries whether the mould attacks the fish in the short space of time it spends at the surface of the water, or whether the spores are dispersed through the water. He sees no reason to doubt that mould should not thrive in water just as well as many plants, "because there are facts which seem to prove the existence of certain species of aquatic mould that are not to be found on terrestrial substances."

After the time of Micheli we find the name *Mucor* generally adopted, though rarely used in the restricted sense proposed by him, and usually including some of his other genera. Haller, 1742, as Micheli, divides the genus into stalked and sessile species (cauliferi and acauli and in 1768 petiolati and sessili). He has five species, two of which are new. Linnaeus in his Species Plantarum, 1753, gathers together a number of species which had been described and gives them binomial names. His treatment of fungi is everywhere much inferior to that of Micheli, but he conferred a very great benefit on the study of mycology by the application of his binomial system. He divides *Mucor* into two sections, one perennial and one fugacious, and this was adopted by the succeeding botanists who followed the Linnaean traditions. (Perennes; *Mucor sphaerocephalus*, *Lichenoides*, *Embolus*, *fulvus*, *furfuraceus*: Fugaces; *Mucor Mucedo*, *leprosus*, *glaucus*, *crustaceus*, *cespitosus*, *Erysiphe*, *septicus*.) It will be seen that Myxomycetes, *Penicillium*, *Aspergillus*, *Erysiphe*, etc., are included. Gleditsch in his Methodus Fungorum, 1753, closely follows Micheli in his classification (and in his illustrations) but his genera have more the limits of those of Linnaeus; he includes both the *Mucilago* and *Lycogala* of Micheli in *Mucor*. Scopoli, Flora carniolica, 1760, has a treatment similar to that of Linnaeus, though he retains the multinomial system of nomenclature, which he rejects in the 1772 edition for the binomial system. Schaeffer, Fungorum Icones, 1767-1772, adopts the generic names given by Linnaeus. In his index he describes his Mucores:—Fungi fructiferi in cauo ouato aut subrotundo varie dehiscente. But all his six species are Myxomycetes. Batsch in his Elenchus Fungorum, 1783, has a classification based on that of Micheli. *Mucor* has seven species, one of which is the Myxomycete *Dictydium cancellatum*.

Bulliard, in his famous Histoire des Champignons de la France, 1791, breaks away somewhat from the traditions of his century. He has four main groups of fungi, the division depending upon whether the spores are produced internally or externally over the lower, upper, or whole surface. *Mucor* appears in the first division together with Myxomycetes, Lycoperdons, etc. The genus is divided into "Mucors, dont les semences sont nues et isolées" (9 spp.), "Mucors, dont les semences nues au sommet des pédicules sont rangées les unes à la suite des autres, comme des grain de chapelet, sur des lignes diverses" (2 spp.), and "Mucors, dont les semences sont renfermées dans un péricarpe vésiculeux" (7 spp.) It seems as if Bulliard, meeting with difficulties which Micheli had solved by making new genera, attempted to expand the limits of the single genus so as to include the various Hyphomycetes which he encountered. This author has some observations on the "seed" of *Mucor*. He points out the fineness of these, floating in the air, and the impossibility of preventing their access to any substance which air can reach—if a substance does not become mouldy it is because it is not a suitable pabulum for the fungus. He indicates the efficacy of keeping substances dry and also "un grand degré de chaleur devoit faire perdre aux graines des Mucors la faculté végétative." Tode in his Fungi mecklenburgenses selecti, 1790-1, does not include *Mucor* in his genera, but has *Pilobolus* near to *Thelebolus*, *Ascophora* near to *Tubercularia* and *Hydrophora* near to *Sphaeria*. *Ascophora* contains *Rhizopus* (in which the columella was interpreted as the sporangium), *Phragmidium*, *Cladosporium* and the stalked egg of *Chrysopus*: *Hydrophora* is possibly the equivalent of *Pilaira*.

We have seen that *Pilobolus* was first described in Ray's Historia. The next account is by Henry Baker in "An attempt towards a natural history of the Polype: in a letter to Martin Folkes, Esq.,"* 1743. Baker (1698-1774) was in his earlier years a poet, and having practised on a relative who was deaf and dumb, made the education of deaf mutes his chief employment. Having married the daughter of Daniel Defoe, he collaborated in journalism with that prolific writer. He wrote on the microscope, and for his researches on crystallisation, etc., received the Copley medal of the Royal Society. He is remembered by having introduced rhubarb and alpine strawberry into this country, and by the Bakerian oration of the Royal Society provided for by him in his will. In a chapter "On a microscopical discovery" he writes: "Having lately had the Pleasure of shewing, Sir, to You and several other curious Gentlemen a

* President of Royal Society.

Discovery made by the Microscope, which both You and They have judged worthy Notice; I hope it will not be thought improper to add it to these Experiments.

"Keeping a small Quantity of the black Mud of the *Thames* with some Worms therein to feed my *Polypes*, in an earthen Vessel that contains about half a Pint; I poured every Day a little Water thereon, to supply the Worms with fresh Nourishment and prevent their becoming putrid. This Water, however, I constantly drained off in a few Minutes, leaving none of it in the Vessel but what the Mud soaked in; so that it appeared always moist, but never wet.

"In some Mud that had been thus treated for about a Fortnight, I observed in many Places, and particularly about its Edges, on the sixteenth of last *September*, a great many glittering and shining minute Bodies, in Appearance and Size not much unlike some of the clear transparent Grains of large Sea-Sand, which indeed at first I imagined them to be: but examining them with more Attention, I could perceive with my naked Eye, that they were little transparent oval Bodies, about the twentieth of an Inch in Height, having a small black Crown or Button at the Top of each. They stood upright in the Mud pretty close together, and made a very pretty Appearance.

"Pleased with this Sight, I immediately placed one of them before the Microscope, and found the Shape thereof exactly resembling a *Florence* Flask with the Bottom upwards, and thereon a round Button or Crown somewhat depressed upon the Top, as in the Figure. The Body and Neck of the Flask, if I may term them so, appeared as if full of the clearest Water, and were so perfectly transparent, that when their *Focus* was adjusted to the *Focus* of the Magnifier, the Windows of some opposite Houses could plainly be distinguished through them; and, as you was pleased to observe, were represented inverted in the same Manner they would have been if seen through a Piece of Glass of the like Form.

"The Crown, Cap or Button at Top was black on the upper Part, with certain irregular little Ramifications thereon of somewhat a whitish Cast: but down its Sides to where it joyns the Flask it was of a yellowish tawny Colour; and the Flask itself had a little yellowish Tinge when viewed in a Side-Light.

"While I was examining this curious Object, the Sides of it began to shrivel, collapse together, and grow opake, by the drying of the little Lump of Mud whereon it stood: but upon applying a Drop of Water thereto, in a Minute's Time it became again plumped out and transparent under my Eye, and seemed as before, like a Glass filled with Water.

"This seems to be a minute Plant, not yet, I think, described:

of a very extraordinary Form and Growth. Its Root is in the Mud, whence it rises on a Stalk or Stem like the Neck of a Flask; and, probably, the black globular Body on the Top is its Fruit or Seed.

" They continued a few Days, but cold Weather coming on, they disappear'd all together."

There is no doubt that the figures and description refer to *Pilobolus*. The famous Otto F. Müller next described the fungus which he had found in 1764. Touching it with his fingers he felt a movement and heard a noise which apparently surprised him—possibly that heard when the sporangium is projected. He gives a good description and figure of this Kristallschwämmchen; but in many of the sporangiophores he observed a white and very slender worm (? *Rhabdites terricola*) which he picturesquely describes as arbitrarily swimming about in a small ocean. " What shall we think of these phenomena? A species of plant, which changes into a small crystalline club enclosing a living worm, and a few hours after that becoming transformed into a fungus; in the morning transparent, in the afternoon a darker body; a small animal, which has a very bright residence, which swims in the clearest moisture, and in a second becomes enveloped by a thick cloud and closed in a thick body." Naturally the question is asked as to what it is to be named and into which kingdom it has to go. The three main kingdoms, animal, vegetable and mineral have obviously too restricted boundaries to enclose such a wonder, which partakes of the properties of each. A fourth kingdom is proposed to contain it, Polypes and Infusoria, in which also Müller had previously discovered somewhat similar transformations.* He considers that the black heads contain the seeds and remarks upon the short life of the organism which he could obtain overnight by moistening horse dung.

Scopoli next describes the fungus which he had found in earth in which preserved a larva of *Sphinx atropus*. He recognised its true affinities and gave it the name *Mucor obliquus* from the oblique manner in which the stem frequently arises from the basal reservoir. Withering in 1776 names Petiver's plant " Dew drop mould," *Mucor roridulus*, but it would seem he was unacquainted with the fungus, as he puts it, in the permanent section of the genus, though he queries its permanency.

Wigger's Primitiae Florae Holsaticae (1780) contains an account of this beautiful and singular fungus—probably by G. H. Weber. A new genus, *Hydrogera*, is proposed for it, but this name has apparently only been adopted in Flora Danica

* Müller ranked *Clavaria* amongst the Vermes in sub-division Fungosa osculis atomiferis.

and Roth's Flora germanica. The single species, *H. crystallina*, is diagnosed. Wiggers regards fungi as being of uncertain position and rather favours the opinion of Münchhausen, Weis, Fellner and Weber, that they are zoophytes. The next mention of the genus is H. F. Tode's "Beschreibung des Hutwerfers (pilobolus)." He gives an excellent description of the fungus which he names *Pilobolus crystallinus*, and there gives several points about the life history which were missed by later writers.

In British books J. Dickson (Fasc. Plant. Crypt. Brit.), 1785, figured and described a species of *Pilobolus* with the name *Mucor urceolatus*, which he regards as the same as Wiggers' species: and Bolton, in his History of Funguses, growing about Halifax, 1787, has two species, *Mucor roridus*—"Eyed-Mould"; "It is pellucid and white, sustaining a small globular head, like a minute pearly drop, with a black spot on its upper part; which give the globe the resemblance of an eye in miniature. Grows on horse-dung, in cloudy mornings; perishes when the sun shines upon it"—and *M. urceolatus*—"Pitcher-shaped Mucor."

After publishing several papers on fungi Persoon gathered together his results in his Synopsis Fungorum, 1801, a work which stands out clearly in tracing the history of fungus classification. His two great divisions are Angiocarpi and Gymnocarpi. The former is divided into Sclerocarpi, Sarcocarpi and Dermatocarpi. *Pilobolus* is placed in the Sarcocarpi together with *Thelebolus*, *Sphaerobolus*, *Sclerotium* and *Tuber*—"vesicula in tribus his generibus elastice prosilit." The order Dermatocarpi is divided into Trichospermi, Gymnospermi and Sarcospermi. *Mucor* occurs in the Gymnospermi—"pulvere nudo s. filis non reticulato"—with such genera as *Licea*, *Onygena*, *Aecidium*, *Uredo*, *Puccinia*, and *Trichoderma*.

Persoon's classification was followed by many writers, *e.g.*, Albertini and Schweinitz, Hooker and Secretan.

De Candolle, Flore française, 1805, has the two main groups of Persoon, but has a third division, Hypoxylons, which contains principally Pyrenomycetes and Hysteriaceae. *Mucor* occurs after *Aecidium* in the Angiocarpi (Péridium membraneux rempli de poussière non entremêlée de filamens): *Pilobolus* between *Stictis* and *Thelebolus* (Péridium membraneux ou charnu, non pulvérulent).

In his Traité sur les champignons, 1818, Persoon has a more natural classification, but the treatment is general. Six orders are proposed:—Byssoïdes (Byssi, Trichomyci), Champignons proprement dits (Fungi, Hymenomyci), Champignons à graines nues (Phaeomyci), Champignons à poussière (Lycoperdacées, Coniomyci, Gastromyci), Champignons cartilagineux (Sclero-

myci), and Champignons cornés (Xylomyci). Mucorinées are placed in the fourth order "composées seulement de deux ou trois genres qui sont les *Mucor* (Ascophora) les *Eurotium*, sont aussi mis dans cet ordre à cause de leur enveloppe ou péridium qui contient des graines nues. Elles ont le port et la manière de croître des moisissures; mais elles n'ont pas la nature ni des Lycoperdacées ni des Trichiacées." *Pilobolus* is still classed with *Thelebolus*, *Sphaerobolus* with the addition of *Nidularia* in the Carpoboli or Sarcospermi, which are placed in the third order.

Link in Ordines plantarum naturales, 1809, has four main divisions, Epiphytae, Mucedines, Gastromyci and Fungi. The first section of the Gastromyci contains principally Myxomycetes with the addition of *Ascophora*, *Mucor*, *Eurotium*, and *Thamnidium* (n.g.). *Pilobolus* is placed near to *Sphaerobolus* in the third section. Link was the first observer to attribute the throwing off of the sporangium to the tension of the swelling below it.* In 1815 *Pilobolus* forms with *Mucor*, *Eurotium*, *Thamnidium* and *Ascophora* the series Mucidi of the order Gastromyci.

Later, 1824, Link divides fungi into Hyphomycetes, Gymnomycetes, Gasteromycetes, Sarcomycetes, and Scleromycetes. Each of these is split up into series. The third series of Hyphomycetes contains *Aspergillus*, *Penicillium*, etc., and *Phycomyces*, a genus which had been proposed by Kunze the previous year for the reception of Agardh's *Ulva nitens*. The fifth series (Sporangia floccis innata aut adnata) contains *Eurotium*, *Mucor*, *Sporodinia* (n.g.), *Syzygites*, *Pilobolus*, *Thamnidium*, the doubtful genera of Martius (1821)—*Thelactis*, *Didymocrater*, and *Diamphora*—with *Erysibe*, *Antennaria*, and *Rhizoctonia*.

Nees von Esenbeck in his System der Pilze, 1817, has a group Nematomyci which he divides into Mucedines, Byssi and Mucores. The last is formed of Nematomyci and Trichomyci; Nematomyci is sub-divided into Nematomyci tegentes *(Trichoderma)* and Mucedines vesiculiferae *(Thamnidium*, *Mucor*, *Ascophora* and *Pilobolus)*. *Eurotium* is in the Gasteromyci.

Brongniart, Classification naturelle des champignons, 1824, divides his Mucédinées into Phyllariées, Mucorées, Mucedinées vraies, Byssacées and Isariées. His Mucorées is almost identical with Link's fifth series (1821).

We now come to the Systema Mycologicum of Elias Fries, a work which has had a greater influence on

* Link was apparently the first to apply Hedwig's term sporangium to the fruit of fungi. He also first uses the name sporidium in this paper for spore. The term mycelium was first used by Frattinick, Fungi Austriaci, 1805.

systematic mycology than any other treatise. In the introduction (1821) Fries places the Mucoroidei *(Hydrophora, Thamnidium, Ascophora, Pilobolus)* in the Gasteromycetes. *Pilobolus* in 1823 (Vol. II.) he retains in the Gasteromycetes (Angiogastres-Carpoboli) with *Sphaerobolus* and *Thelebolus*, but in 1833 (Vol. III.) he again places it in its natural position. All the known Phycomycetes are now placed in the Hyphomycetes, the second order of which is Mucorini, containing the genera of Mucorineae proposed up to then together with genera such as *Stilbum* and *Eurotium*. In 1849, in his Summa, the Mucorinei still form a portion of the Hyphomycetes but contain no Fungi Imperfecti. He says, however, "Mucorineos a Mucedinibus familia movere impossibile mihi semper visum fuit."

Turning to a consideration of British works we find that all the floras written after the time of Linnaeus up to Hooker's Flora Scotica followed his division of the genus *Mucor*, merely adding a species or two. S. F. Gray in his Natural Arrangement of Plants, 1821, has a classification partly based upon that of Nees von Esenbeck.* His Nematomyceae he divides into eight families, Mucedineae, Aspergillideae, Mucoroideae, Stilbideae, etc. Four genera are included in the Mucoroideae, *Thamnidium, Mucor, Ascophora* and *Pilobolus*. R. K. Greville in his Scottish Cryptogamic Flora, 1821-1828, has a classification based on that of Fries. M. J. Berkeley in the English Flora, 1836, follows Fries very closely and still retains *Pilobolus* near *Thelebolus* and *Sphaerobolus*, but states that it is perhaps better associated with Hyphomycetes, between *Ascophora* and *Hydrophora*. Later, in his introduction to Cryptogamic Botany, 1857, he has two divisions of fungi, Sporifera with naked Spores, and Sporidiifera with sporididia in asci. For *Mucor* and its allies he proposes the group Physomycetes, which he regards as being exactly intermediate between Ascomycetes and Hyphomycetes. Physomycetes and Ascomycetes together form the Sporidiiferi. The same classification is retained in his Outlines of British Fungology, 1860: Physomycetes: Antennariei, *Antennaria, Zasmidium;* Mucorini, *Ascophora, Mucor, Hydrophora, Endodromia, Sporodinia, Acrostalagmus, Syzygites, Endogone*. The genus *Peronospora* was placed in the Mucedines. *Pilobolus* seems to be omitted altogether. M. C. Cooke adopts this classification in his Handbook of British Fungi, 1871. He includes Saprolegniei with a very guarded statement as to its position. (Berkeley had not

* Owing to the death of Sir Joseph Banks, whose library and herbarium Gray had used, there was "great delay, in being obliged to await the arrival of another copy of Esenbeck's work from Germany, that those interesting plants the fungi might be arranged according to the latest improvements."

included them though he felt convinced "they are really states of Fungi"). *Saprolegnia*, *Achlya* and *Aphanomyces* are mentioned but there are no descriptions. *Empusa* is given under *Saprolegnia ferax* as "an imperfect condition of the same." *Peronospora* is still in the Mucedines and *Cystopus* in the Uredines, which speaks much for the conservatism of British mycologists. The classification adopted in Fungi, their nature, influences and uses, is to all intents and purposes the same.

Corda in his Icones Fungorum, 1837-1864, figured many of the fungi under consideration and followed mainly the classification he displayed in his Anleitung 1842. This classification, although excellent in parts, in others consists of a most remarkable association and mixing of genera. Fungi are divided into Coniomycetes, Hyphomycetes, Myelomyceten and Hymenomycetes. The genus *Peronospora* proposed by Corda in 1837 is placed in the Hyphomycetes. The Myelomyceten are a very strange medley: there are two sections, Dermatogasteres and Sclerogasteres. The former contains Mucoroideae, Pilobolideae, Aecidiaceae, together with Myxomycetes and Gasteromycetes; the latter Pyrenomycetes, Sphaeropsideae, etc. There is now a division of the Mucoroideae:—Crateromycetes: *Crateromyces*, *Didymocrater*, etc.; Mucoroideae verae: *Mucor*, *Rhizopus*, *Helicostylum*, etc., and Diamphoreae: *Diamphora*. The family Pilobolideae is composed of the genera, *Pilobolus*, *Pycnopodium*, *Chordostylum*, and *Caulogaster*. Bonorden, Allgemeine Mykologie, 1851, adopts much of Corda's classification. He has twelve principal divisions, one of which is Mucorini: this is composed of Crateromycetes (including *Diamphora*), Mucores, and Pilobolidei.

Leveillé in 1848 proposed a classification in which Zygomycetes (under the name Cystisporés or Cystosporés) are given greater prominence than in any previous system. There are six main divisions: Basidiosporés, Thecasporés, Clinosporés, Cystisporés, Trichosporés, and Arthrosporés. The Cystosporés are divided into Columellés (Cratéromycés; *Crateromyces*, *Diamphora*, etc.; Ascophorés: *Ascophora*, *Rhizopus*, *Mucor*, etc.) and Saprophilés (Mucorinés: *Hydrophora*, *Helicostylum*, *Acrostalagmus;* Pilobolés: *Pilobolus;* and Syzygités?: *Syzygites. An alga aerea?*).

The fungus *Syzygites megalocarpus (Sporodinia)* can be identified from the old descriptions because of the dichotomous branching of the sporangiophores and of its occurrence on decaying agarics. What is probably the first mention of it occurs in Scopoli's Flora Carniolica 1760—*Mucor capitulis aqueis; stipite dichotomo, setaceo, procero* which becomes *Mucor Aspergillus* in the second edition probably because the author considers it to be the same species as *Aspergillus ramosissimus*

in globulos terminatus of Haller's Historia Helvetiae (1768). The fungus received many names, Persoon bestowing three upon it and Link four. It was in this fungus that Ehrenberg discovered the first known sexual process in fungi, giving figures of the well-known copulation series. He suggests that a similar sexual act will be found to occur in many, probably in all, the lower forms, which prophesy has been amply fulfilled. He noted the streaming of the protoplasm but mistook the oil drops in the zygospore for spores, which mistake was not corrected until the time of Tulasne. The method of sexual reproduction was compared with that of the Conjugatae. It was not realised for many years that the sporangial stage and the zygospore stage were states of the same fungus, and all the fungus books treated *Sporodinia* Link and *Syzygites* Ehrenberg as two different genera. It was not until 1855, that Tulasne stated that they were one and the same fungus, the zygospores arising on the same mycelium as the conidiophores. De Bary and Schacht in 1864 independently published accounts of the experimental proof of the identity. The researches of Tulasne, which firmly established the doctrine of pleomorphism, were the cause of many mycologists of a somewhat different psychology leading themselves, and others, astray. The account given by de Bary of these theories sufficiently explains the facts. " Tulasne's doctrine of pleomorphy raised indeed a storm of controversy that lasted for some time. On the one hand a conservative opposition was naturally to be expected on the part of those who had already enquired into the species of Fungi, and had become accustomed to find a species in every detached form with some kind of spore-formation, disregarding entirely the question of the course of development and genetic connection. The most aggressive representative of this conservative opposition was perhaps Bonorden; others were more cautious and professed to be open to conviction.

On the other hand a misunderstanding of the word pleomorphy led men of enthusiastic character to extravagant conclusions. ' The explanation of all enigmatical fungal forms has been reserved,' it was said, ' for our decade,' and the appearance of two or more different fungal forms in the same spot close to each other, or one after the other, was regarded at once as a case of pleomorphy of one species and proclaimed as loudly as possible. Many experiments in culture were also undertaken, and here too every thing that grew on the spot which had been purposely sown found its place if possible in the cycle of whatever pleomorphous species the observer happened to think of. If the character of the substratum was changed in such cultures, the fungal forms that were obtained were often different; nor could anything be more desired, for

the phenomenon of pleomorphy appeared now to have found its physiological explanation in the effect of the various physical and chemical qualities of the substratum. This gave rise to accounts such as the following: *Saccharomyces Cerevisiae*, the Fungus of beer-yeast, grows in saccharine fluids in the form indicated by the name. If it is eaten by flies it develops in them into the primordia of *Entomophthora;* these grow in the dead insects or moist substrata either into the form which bears the last name or into *Mucor*, but into *Achlya* if the flies fall into water. Finally *Saccharomyces* may again be formed from *Mucor* in saccharine fluids, etc. etc. Bail, Hoffmann, and especially Hallier, were the chief representatives of these pleomorphistic extravagances. Others eager to share the laurels of these discoverers modestly adopted their views." It was de Bary himself who pointed out clearly that what was requisite was that connection should be traced at all points of a life history: "this is simply the method by which we determine that the apple is a product of development of the apple-tree, and that the tree is produced from the apple; the logic does not change with the size of the objects or with our apparatus and manipulation."

The formation of zygospores was studied in other genera, particularly by Brefeld, van Tieghem and Le Monnier. Brefeld in 1872 proposed the name Zygomycetes for these fungi in contrast to the Peronosporaceae, Saprolegniaceae, etc., with their differentiated oogonia, which families he afterwards united under the name Oomycetes. Blakeslee's discovery of homothallic and heterothallic strains has explained much of the difficulty that was previously met with in the investigation of zygospore formation.

The first species of the genus *Cystopus* to be described was *C. candidus*. Persoon in Gmelin's Systema Natura, 1791, gave to it the name *Aecidium candidum*. In 1795 the same author proposed the genus *Uredo* to include this fungus and two new species, and in 1801, as the genus had increased much in size, divided it into four sections, one of which, *Albugo*, being characterized by having white spores. Roussel in 1806 raised this section to generic rank, and in this was followed by S. F. Gray (1821). Leveillé in 1847 used the name *Cystopus*. Prévost in 1807 studied the structure and germination of species of *Uredo* and similar fungi. He found that the spores of *U. Portulacae* after being immersed for a time in water gave rise to zoospores. Tulasne attempted to confirm Prévost's results, but failed, and in 1855 still placed the fungus in the Uredineae § Albuginei. Other investigators met with no greater success until de Bary in 1860 confirmed Prévost's results and in 1863 recorded the presence of sexual organs which had escaped the notice of previous investigators.

The genus *Peronospora* had been proposed in 1837 by Corda and placed near to *Polyactis* in his Aspergillini. One species at first known as *Botrytis infestans* became of great economic importance in the early forties. Vast quantities of literature were written on the subject of the potato murrain regarding it from every possible point of view and attributing it to every possible cause.* It was the investigation of the relation of the fungus to the disease that laid the foundations of plant pathology. At least four European countries held commissions to enquire into cause and effect. Later, de Bary proposed the generic name *Phytophthora* for this fungus.

The first reference to any member of the Saprolegniaceae which I have been able to find occurs in H. E. Ledermüller's Mikroskopische Gemüths und Augen-Ergotzung, 1761. This is one of those miscellaneous collections of observations made with a microscope, which began with Hooke's Micrographia. Everything which came to the hand was placed under the lens. One of the coloured plates in Ledermüller's work refers to "Eine schwimmende Pfifferinsel." A glass of water in which he washed his paint brush had been left standing, and in it a gnat had fallen and was floating on the surface surrounded by a fungus with a number of threads passing from beneath it to the base of the glass. This composed his floating fungus island " with a million small green fungi. Never did a creature receive a more beautiful tomb, than this gnat found in my glass." Ledermüller considers that it cannot be contradicted that the air is full of all kinds of fungus seeds which are light and blown about by the wind. The gnat, a flying insect with both large and small hairs, would get the spores before falling into the water, where they would develop. The figures given are not clear; possibly the green fungus is *Eurotium*, the one passing down into the water doubtless one of the Saprolegniaceae.

Another reference is found in H. A. Wrisberg's Observationum de Animaculis Infusoriis satura, 1765, where Typhae nigricantes ex meris vesiculis uvae instar concretae is described and a somewhat poor figure given of what is a species of the group. Spallanzani's reference in 1777 has already been noted. Flora Danica 1782 gives a figure of a species of *Achlya* under the name *Byssus aquatica.* (The generic name *Byssus* was used by most authors, and included a heterogeneous mass of various affinities.) M. E. Bloch, 1782, in his book on the economic natural history of fishes describes a disease of carp which he

* For an account of the great political effects *Phytophthora infestans* had in this country see Justin McCarthy's " A History of our own times," chap. XV. It is not given to many fungi to become Cabinet wreckers and to be the occasion of a change in fiscal policy.

says is known by the name "Mooss." He gives a short account of the conditions under which this sometimes fatal disease arises. Schrank having found the same disease affecting fishes gives it the name *Conferva piscium* in his Baiersche Flora, 1789, and indulges in some Müllerian speculations.

Dillwyn in his Synopsis of British Confervae, 1802-1809, has a plate with the name *Conferva lactea* which he regards as a species which he quotes Roth* as naming first *Conferva lactea* and afterwards *C. pusilla*, and which is clearly the species most often known as *Leptomitus lacteus*. In his text he says: "I have found the present species in several places in Walthamstow and its neighbourhood, as also about Swansea, and I am inclined to think it is by no means unfrequent during the winter months." Lyngbe, 1819, figures the species of Flora Danica with the name *Vaucheria aquatica*. A couple of years later Gruithuisen described a fungus found on the remains of a dead snail; he calls it *Conferva ferax*, and figures the zoospores escaping from the sporangium of a species of *Saprolegnia*, though without cilia. He also figures a second and third sporangium within the first. Carus, 1823, described a fungus on salamander larvae with spores collecting at the mouth of the sporangium in the form of a sphere. He questions whether it should be regarded as a fungus or an alga, as Gruithuisen had done before him, and proposes the name Wasserschimmel or *Hydronema*. Nees ab Esenbeck in an appendix to the paper establishes the genera *Saprolegnia* and *Achlya* on the method of sporangial emptying (Hydronemateae. A. Tremelloidea. B. Oscillantia. C. Confervoidea. *Saprolegnia*, *Achyla*, *Pythium*). The genus *Pythium* he founded for the reception of two species described by Schrank in 1813, *Mucor spinosus* and *M. imperceptibilis*, which were probably species of *Achlya*. (The genus *Pythium* of Pringsheim, 1858, is totally different.) In 1824 Agardh, Systema Algarum, included all the previously described forms in his genus *Leptomitus*, using the substrata as the principal point in their arrangement. The species are very ill-defined, only one, *L. lacteus*, out of the ten species in the section "vegetabilibus exortae," being recognisable. Kützing in his Phycologia generalis, 1843, has the same sort of heterogeneous group in his genus *Leptomitus*, having one recognisable species out of twelve: the remaining known forms are placed in *Saprolegnia* with three species.

Meyen (1839) and others described the formation and escape of zoospores, and this naturally confirmed many in their opinion that these organisms were algae, an opinion which was made even more secure when Braun (1851) found that the oospores

*I have not been able yet to discover these names in Roth's works.

observed by Schleiden (1845) and Naegeli (1847) arose by a well marked sexual process similar to that known in certain algae. After the excellent work of Pringsheim (1851) and de Bary (1852) our knowledge of the group became much more exact. It was the discovery of a sexual process in *Peronospora* (Tulasne 1854) and *Cystopus* (1863), and the occurrence of zoospores in both these genera that convinced de Bary of the relation of the Saprolegniaceae to these.

De Bary has a classification of fungi in the appendix to Streintz Nomenclator Fungorum 1862. The first three families are Peronosporei, Protomycetei, Mucorini. As a note to the first family he writes "Sectis Saprolegnieis ideoque confervis valde affinis alio loco amplius illustranda." Four years later, in the first edition of his text book, this family is added, the sequence being Saprolegnieen, Peronosporeen, Mucorinen. (*Protomyces* is placed near the Tuberaceae.) In the classification adopted by Fuckel, 1869, in his Symbolae Mycologicae, the Fungi Perfecti are arranged according to de Bary:—Basidiomycetes, Hypodermei, Phycomycetes and Ascomycetes. The Phycomycetes are divided into Peronosporei, Saprolegniei, Mucorini, Chytridiei and Protomycetei. De Bary's last classification was contained in the second edition of his text book, 1884:—

Series of the Ascomycetes.
Peronosporeae (with Ancylisteae and Monoblepharis).
Saprolegnieae.
Mucorini or Zygomycetes (Mucoreae, Chaetocladieae, Piptocephalideae).
Entomophthoreae.
Ascomycetes.
Uredineae.

Groups which diverge from the series of the Ascomycetes or are of doubtful position:—

Chytridieae (Rhizidieae, Cladochytrieae, Olpidieae, Synchytriae).
Protomyces and Ustilagineae.
Doubtful Ascomycetes (Saccharomyces, etc.).
Basidiomycetes.

The disease of flies caused by *Empusa domestica* was mentioned by C. de Geer in his Mémoires pour servir a l'histoire des insects, 1776. "Il arrive quelquefois à ces Mouches & à celles de quelques autres espèces, une maladie mortelle & des plus singulieres. Le ventre s'enfle extraordinairement & jusqu' à en crever la peau; les anneaux se déboitent & les piéces écailleuses, qui les couvrent tant en dessus qu'en dessous, s'éloignent les unes des autres; la peau membraneuse qui se trouve entre ces mêmes piéces, se présente alors très-tendue & toute blanche;

enfin en ouvrant le ventre, on le trouve tout rempli d'une matière onctueuse blanche, qui souvent penètre la peau & s'accumule sur la surface extérieure du corps. On trouve souvent les Mouches dans cet état, mortes & accrochées sur les murailles, les fenêtres & les plantes des prairies, ayant quelquefois le bout de la trompe collé contre le plan de position, & paroissant au premier regard comme si elles étoient vivantes. La cause de cette maladie m'est inconnue; il paroît comme si ces Mouches avoient mangé quelque chose de venimeux." A not very illuminating figure is given of one of these diseased flies. The famous Goethe gives an accurate account of the naked eye appearances of the phenomena in connection with the appearance of *Empusa*. In 1827, Nees von Esenbeck studied the fungus with the microscope and gave a description which was quite good considering the period. Fries in his Systema gave it the name *Sporendonema Muscae* and placed it in the Mucedines. Many investigations followed, the principal of which were those of Cohn (1855), who founded the genus *Empusa*, and Brefeld (1871). The latter called attention to the similarity of the conidiophore layer to the hymenium of Basidiomycetes: and Winter in Rabenhorst's Kryptogamen Flora, 1881, places the Entomophthoreae with this group. Nowakowski in 1876 observed copulation in species of *Empusa* and proposed the family Entomopthoraceen, which he placed in the Zygomycetes near to the Piptocephalideen.

Physoderma was the first genus of the Chytridiaceae to be described (Wallroth 1833), but its affinities were not understood until much more recent times. The various genera parasitic on algae and Saprolegniaceae were observed by Naegeli, Cienkowski, Pringsheim, and others, but were usually regarded as representing part of the life history of the host—microgonidia, etc. Braun, 1850, was the first to realise that they were parasites, and diagnosed the genus *Chytridium*, in which he described twenty species in 1855, dividing the genus into subgenera. He regards the genus as approaching the Protococcaceae, whereas Cohn considered it showed affinities with the Saprolegniaceae. In 1856 Braun diagnosed the genus *Rhizidium*, speaking of the two genera as Chytrideen. De Bary and Woronin in 1863 added *Synchytrium* and the family became firmly established. Rabenhorst, 1868, attached them to the algae as an appendix to the Siphonomyceen, but adds "Siphophyceis ab algologis permultis adnumerantur Saprolegnieae et Chytridieae, quae ob defectum Chlorophylli et Amyli ex mea sententia ad fungos pertinent et quidem ob zoogonidia vel zoosporas Peronosporeis proximae; attamen ex promisso meo hic enumerabo." Fuckel, 1869, as we have seen, placed the Chytridei among the Phycomycetes, "trotz des noch nicht

aufgefundenen Myceliums." Schroeter in 1870 returns to Braun's opinion and considers them to be best placed near the Palmellaceae. Cornu, the same year, described certain new genera parasitic on Saprolegniaceae. He also discovered *Monoblepharis* and proposed the family Monoblepharidaceae to contain it. Pfitzer, 1872, described *Ancylistes* and included it with Cornu's genus *Myzocytium* in the Ancylisteae, which he placed between Chytridiaceae and Saprolegnieae. Sorokin, 1874, proposed the name Siphomycetes to include these three families together with the Zygomycetes and Peronosporeae.

The genus *Pythium* was founded by Pringsheim in 1858 and placed in the Saprolegniaceae (which Pringsheim regarded as algae). Cornu, 1872, also placed the genus in this family, as did Berlese and De Toni in Saccardo's Sylloge, 1888. Schroeter, 1897, forms a special section, Pythiaceae, for its reception in the Saprolegniineae. De Bary, 1881, classed it with the Peronosporaceae, pointing out its affinities to *Phytophthora*. Zopf, 1890, von Tavel, 1892, Fischer, 1892, follow de Bary.

The more recent classifications have much in common. Brefeld, 1881, divides the Phycomycetes into Zygomycetes and Oomycetes. The former contains Mucorineen, Thamnidieen, Choanephoreen, Chaetocladieen and Piptocephalideen; the latter, Chytridiaceen, Saprolegnieen, Peronosporeen, Entomophthoreen and Ustilageen. Von Tavel in 1892 gives the results of Brefeld's further studies. The divisions are:— Oomyceten; Monoblepharideen, Peronosporeen, Ancylisteen, Saprolegnieen, Chytridiaceen (Cladochytrieen, Rhizidieen, Olpidieen, Synchytrieen), Entomopthoreen: Zygomycetes; (Exosporangische). Mucorinen, Thamnidieen, Chaetocladieen, Choanephoreen, Piptocephalideen, (Carposporangische), Rhizopeen, Mortierelleen. Berlese and De Toni, 1888, divide Phycomyceteae into Genuinae and Recedentes. The former contains Mucoraceae (Piloboleae, Mucoreae, Chaetocladieae, Mortierelleae, Syncephalidieae), Peronosporaceae, Saprolegniaceae, Entomophthoraceae, and the latter Chytridiaceae and Protomycetaceae. (The divisions of the Mucoraceae are those proposed by van Tieghem, 1875.) Zopf, 1890, regards the Chytridiaceen as of equal rank with the Oomyceten and Zygomyceten. The Entomophthoreen are placed in the Zygomycetes. Schroeter's 1885 classification is similar to that of Zopf. It is of interest to note that here the Eumycetes are divided into Chytridiei, Zygomycetes, Oomycetes, Ascomycetes, Uredineae, Auriculariei and Basidiomycetes, thus giving a higher rank to the first three than is accorded to them by other authors.

The classification proposed by Schroeter in Engler & Prantl's

Pflanzenfamilien, 1897, is well known. The Phycomycetes are here divided into Oomycetes and Zygomycetes. In the Phycosporangieae of the former we find Chytridineae (Olpidiaceae, Synchytriaceae, Rhizidiaceae, Cladochytriaceae, Hyphochytriaceae, Oochytriaceae), Ancylistineae (Lagenidiaceae, Ancylistaceae), Monoblepharidineae (Monoblepharidaceae) and Saprolegniineae (Saprolegniaceae, Leptomitaceae, Pythiaceae); and in the Phycoconidieae, Cystopodineae and Peronosporineae in the key, but in the body of the work only the latter which is there divided into Albuginaceae and Peronosporaceae. The Zygomycetes are divided into Mucorineae (Mucoraceae, Mortierellaceae, Choanophoraceae, Chaetocladiaceae, Piptocephalidaceae) and Entomophthorineae (Entomophthoraceae).

Another system which is much used is that of Fischer, 1892, which occurs in Rabenhorst's Kyptogamen Flora. Here the Chytridinae are separated off under the name Archimycetes and divided into Myxochytridinae, Mycochytridinae, and Hyphochytriaceae. The Myxochytridinae contain Monolpidiaceae (Olpidiaceae) and Merolpidiaceae (Synchytriaceae): the Mycochytridinae contain Holochytriaceae (Ancylistaceae) and Sporochytriaceae (Rhizidiaceae, Polyphagaceae): the Hyphochytriaceae is composed of the Cladochytriaceae. The divisions of the Zygomycetes are:—Mucorineae [Sporangiophorae] Mucoraceae (Mucoreae, Thamnidieae, Piloboleae), Mortierellaceae; [Conidiophorae] Chaetocladiaceae, Cephalidaceae; and Entomophthorinae: Entomophthoraceae. The divisions of the Oomycetes:—Saprolegninae: Saprolegniaceae (Saprolegnieae, Apodyeae), Monoblepharidaceae; Peronosporaceae: Planoblastae [Cystopodeae], Siphoblaste [Peronosporeae].

The obvious similarities between Phycomycetes and Green Algae have led many to suggest that they should be united. Cohn, 1872, proposed such a system, Sachs in 1874, and Lotsy, 1907. None of these classifications has yet been satisfactorily worked out, and there seems no likelihood at present of their being adopted in any flora. Several other systems that have not been applied have been omitted from this sketch of Phycomycete classification.

I would express my indebtedness for certain facts on spontaneous generation and the history of the microscope to the writings of Gobi, Moore and Singer.

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THE NEW FOREST FORAY.

25th—30th September, 1916.

The twentieth annual week's fungus foray of the British Mycological Society was held in the New Forest. On Monday, the 25th of September, 1916, the members assembled at the Crown Hotel, Lyndhurst, where a commodious room was reserved for the exclusive use of the members. This constituted the headquarters of the Society for the meeting, and in the evening a specimen of the rare *Battarrea phalloides* (Dicks.) Pers., found by their fellow-member Miss E. F. Noel, at Temple Guiting, Gloucestershire on the 15th of October, 1915, and some specimens of the somewhat rare *Boletus aurantiporus* Howse, from Barnett Hill, Surrey, were placed out on exhibition. The Hon. Secretary announced that he had received a letter from their President, Mr. E. W. Swanton, regretting that he was unable to attend the foray, and also another one from Miss B. Lister informing him of the serious illness of her sister, their Vice-President, Miss Gulielma Lister. Under these circumstances it would be necessary for them to elect a chairman for that meeting pursuant to clause thirteen of their rules. It was unamimously resolved that their immediate past-president (Mrs. E. A. Rea) should be appointed to that post, and the Hon. Secretary was directed to convey to the President and Vice-President the deep regret of the members at their absence.

On Tuesday, the 26th of September, a start was made from the headquarters at 10 o'clock in the direction of Lyndhurst Road railway station. The open heath on the right hand of the road was first explored until the members came to an alder swamp, where bombing operations by the military authorities diverted their route through some beeches interspersed with pleasing lawns. About 1.30 p.m. the main road was crossed and the wealth of fungi in the mixed woods on the left hand side of the road investigated. A traverse was then taken in a northerly direction to the coniferous plantations bordering the Bartley water. On their way several large specimens of *Sparassis laminosa* Fr. were found and many members endeav-

oured to secure these intact with their mycelium still attached to the roots of the Scotch Pines. The Bartley water was then crossed, at first several open plantations of conifers were traversed, then mixed woods and bogs and finally the open ground above the Lyndhurst racecourse was reached. The most noteworthy records for the day were—*Amanita verna* Fr. (syn.*virosa* Fr.), this was subsequently found to be of universal occurrence in the Forest; *Amanita recutita* Fr.; *Armillaria mellea* (Vahl.) Fr. var. *tabescens* (Scop.) Rea & Ramsb., this is the ringless form of *A. mellea* and by some authors referred to a distinct species as *Clitocybe tabescens; Tricholoma immundum* Berk.; this species is undoubtedly the *Collybia fumosa* (Pers.) Bres., but until our British works on mycology are seized of these facts it is perhaps best to record it under this species; *Tricholoma acerbum* (Bull.) Fr.; *Lactarius lilacinus* (Lasch) Fr., *Lactarius volemus* Fr.; *Russula veternosa* Fr.; *Inocybe trechispora* Berk.; *Hebeloma testaceum* (Batsch) Fr.; *Cortinarius* (*Phlegmacium*) *caerulescens* Fr.; *Cortinarius* (*Inoloma*) *bolaris* (Pers.) Fr., *Cortinarius* (*Dermocybe*) *miltinus* Fr., *Cortinarius* (*Telamonia*) *periscelis* Fr., *Cortinarius* (*Hydrocybe*) *dolabratus* Fr., *Boletus calopus* Fr., *Polyporus amorphus* Fr., *Clavaria flaccida* Fr. *Hydnum scrobiculatum* Fr. Miss E. M. Wakefield subsequently reported the discovery of *Hypochnus cinerascens** Karst., which is an addition to the British Fungus Flora. In the evening, at nine o'clock, Mrs. E. A. Rea took the chair, and the following officers were unanimously elected for the ensuing year:—Miss A. Lorrain Smith, F.L.S., President; Miss Gulielma Lister, F.L.S., Vice-President; and Mr. Carleton Rea, B.C.L., M.A., &c., Hon. Secretary and Treasurer. Shrewsbury was selected as the centre of the autumn foray of 1917, from Monday to Saturday, the 24th to the 29th of September, and the Hon. Secretary was requested to consult their fellow member Mr. W. B. Allen as to the best localities to be visited on each day. Mr. J. Ramsbottom M.A., F.L.S., was appointed delegate to represent the British Mycological Society at the Conference of Delegates of Corresponding Societies of the British Association in 1917. The Hon. Treasurer reported that since the Swansea foray two new members had been elected; Mr. C. O. Farquharson, Government Mycologist, Ibadan, South Nigeria; and Mr. A. B. Lister, D.I.C., B.Sc. (Lond.), Experimental and Research Station, Turner's Hill, Cheshunt, Waltham Cross, Hertfordshire. They had lost by death the Rev. D. C. O. Adams, Miss Blanche Shadwell and Lieut-Col. J. W. Ellis, and the list of members now only numbered one hundred and thirty seven. The credit balance

* See description, p. 477.

at the post office savings bank now amounted to the sum of eleven pounds, nine shillings and one penny. A vote of condolence with Mrs. A. Ellis and her family was passed, and the Hon. Secretary was directed to convey the same to them with an expression of their appreciation of the excellent work done for the Society by their late fellow-member Lieut-Col. J. W. Ellis. Professor P. A. Saccardo of Padua, the eminent Italian mycologist, was unanimously elected the second honorary member of the Society. An application from Mr. John Ballinger, the Librarian of the National Library of Wales, Aberystwyth, dated the 16th November, 1915, was read, asking that a copy of all future Transactions of the British Mycological Society should be forwarded to the National Library of Wales, and asking also for a gift of any of the past Transactions. It was resolved that a copy of the Transactions for the year 1916 and succeeding years should be sent when published.

On Wednesday, the 27th of September, the forenoon was devoted to the placing out on exhibition the fungi collected on the previous day. These also included some rare and interesting species sent by their fellow-member, Mr. W. B. Allen, from Tick Wood, Shropshire, viz: *Amanita strobiliformis* Vitt., *Amanita solitaria* (Bull.) Fr., *Tricholoma imbricatum* Fr., *Lactarius scrobiculatus* (Scop.) Fr., *Cortinarius* (*Phlegmacium*) *infractus* (Pers.) Fr., *Cortinarius* (*Phlegmacium*) *fulgens* (A. & S.) Fr., *Cortinarius* (*Phlegmacium*) *fulmineus* Fr., *Cortinarius* (*Phlegmacium*) *testaceus* Cke., *Cortinarius* (*Inoloma*) *argentatus* (Pers.) Fr., *Cortinarius* (*Inoloma*) *Bulliardi* (Pers.) Fr., *Cortinarius* (*Dermocybe*) *cotoneus* Fr., *Cortinarius* (*Hydrocybe*) *armeniacus* (Schaeff.) Fr., and *Hydnangium carotaecolor* Berk. At 12 o'clock the members proceeded from the head-quarters and searched the woods and lawns bordering the Christchurch road. Many of the members confined their attention to the portion of the Forest on the north side of Alum Green; whilst a few others crossed the Lymington river and by many devious by-paths reached Mark Ash, famous for its noble beeches. Fungi were abundant everywhere but only a few uncommon species were collected, namely: *Tricholoma spermaticum* (Paul.) Fr., *Collybia lancipes* Fr., *Hygrophorus Reai* Maire, *Hygrophorus unguinosus* Fr., *Nolanea proletaria* Fr., and *Cortinarius* (*Myxacium*) *mucosus* (Bull.) Fr. In the evening Mrs. E. A. Rea took the chair at 9 o'clock, and Mr. A. A. Pearson proceeded on behalf of Mr. E. W. Swanton to read his presidential address, entitled "Education in Mycology" (see p. 381). Dr. W. T. Elliott, L.D.S., R.C.S., F.Z.S., followed with a paper on "Some

observations upon the parasitism of *Badhamia utricularis*" (see p. 410).

On Thursday, the 28th September, the critical examination of the fungi collected occupied the morning until mid-day, when the headquarters were left and the road taken leading in the direction of Brockenhurst. As soon as the open Forest was reached the members spread out in all directions, reuniting from time to time to discuss the more important finds. On one of these occasions Dr. Somerville Hastings most kindly consented to take a photographic group of the members which is reproduced on the page facing this report. The walk was then continued through Park Ground Enclosure and back to Lyndhurst. The following fungi were noted during the day:—*Amanita porphyria* (A. & S.) Fr., *Omphalia philonotis* (Lasch) Fr., *Lactarius helvus* Fr., *Lactarius picinus* Fr., *Russula atropurpurea* (Krombh.) Maire, *Russula citrina* Gill., *Russula punctata* (Gill.) Maire, and var. *violeipes* (Quél.) Maire, *Craterellus sinuosus* Fr., *Entoloma Bloxamii* Berk., *Entoloma speculum* Fr., *Inocybe petiginosa* (Fr.) Quel., *Inocybe fulvella* Bres., *Cortinarius (Phlegmacium) fulgens* (A. & S.) Fr., *Cortinarius (Dermocybe) cotoneus* Fr., *Cortinarius (Telamonia) bulbosus* (Sow.) Fr., *Cortinarius (Telamonia) stemmatus* Fr., *Hypholoma pilulaeforme* (Bull.) Fr., *Fomes resinaceus* (Boud.) Rea, *Fomes Ribis* (Schum.) Fr. (always at the base of *Crataegus Oxyacantha*), *Clavaria formosa* (Pers.) Fr., *Hydnum udum* Fr., and *Femsjonia luteo-alba* Fr. Miss E. M. Wakefield also found *Hypochnus zygodesmoides** (Ell.) Burt, and *Hypochnus botryoides*† (Schw.) Burt, for the first time in Britain.

In the evening, at 9 o'clock, Mrs. E. A. Rea took the chair, and Mr. J. Ramsbottom, M.A., F.L.S., read a paper on "Education in plant pathology" (see p. 378). Dr. Somerville Hastings, M.S., F.R.C.S., then described "Some observations made by him on the eating of fungi by rodents," illustrated by some excellent photographs; these he has since embodied in a paper (see p. 364). Mr. J. Ramsbottom, M.A., F.L.S., concluded with a paper on "The History of the Classification of the Ustilaginales."

On Friday, the 29th September, the morning was fully occupied in arranging the specimens, and it was well past noon before the members started in the direction of Emery Down. Crossing the open green near the modern church and proceeding through the woods, a fine circle of the beautiful *Clavaria flava* (Schaeff.) Fr. was noticed. This differs from the other large Clavariae in its very brittle texture, and

* See description, p. 476.

† See description, p. 477.

THE BRITISH MYCOLOGICAL SOCIETY.

New Forest Autumn Foray, 25th to 30th September, 1916.

C. J. Sharpe. G. H. Pethybridge. F. Pethick Lawrence.
J. Ramsbottom.
J. H. Bloom. B. K. Taylor.
C. Nicholson. A. A. Pearson. C. Rea (Hon. Sec.). J. S. Bayliss Elliott. D. Mackenzie.
H. G. Peacock. A. D. Cotton. E. A. Rea. W. T. Elliott. C. H. Grinling. E. E. Noel. E M. Wakefield.

the flesh turning reddish when handled or cut. Later in the day in close proximity some fine specimens of *Clavaria formosa* (Pers.) Fr. were obtained. The next more important finds were *Amanitopsis nivalis* (Grev.) Rea, *Russula aurata* (With.) Fr., *Russula alutacea* (Pers.) Fr., and *Amanita excelsa* Fr. The walk was then continued up a wooded valley, but owing to the failure of the light an early return was made to Lyndhurst. In the evening Mr. Charles Nicholson, F.E.S., 35, The Avenue, Hale End, Chingford, Essex, was unanimously elected a member.

On Saturday, the 30th September, some of the members had a morning's foray in the woods to the north of the racecourse. Several additions to the list of fungi were made, and included *Amanita recutita* Fr., *Collybia distorta* Fr., *Cortinarius (Inoloma) pholideus* Fr., *Cortinarius (Dermocybe) cinnamomeus* (Linn.) Fr., var. *croceus* (Schaeff.) Fr., *Cortinarius (Dermocybe) semisanguineus* Fr., *Cortinarius (Telamonia) armillatus* Fr., *Cortinarius (Telamonia) incisus* (Pers.) Fr., *Cortinarius (Hydrocybe) obtusus* Fr., and *Clavaria botrytis* (Pers.) Fr. This Clavaria is distinguished from the other larger Clavariae not only by the bright red tips of the branches, but also by the very pleasant fruity smell. A belated parcel sent off by our member, Mr. Norman G. Hadden, from Porlock, Somerset, on the 24th of September, was only received late in the afternoon and was consequently seen by only a few members. It contained some rare Uredinales, namely: *Uromyces sparsus* Lév. on *Spergularia salina, Uromyces Salicorniae* de Bary, *Uromyces Orobi* Lév. and *Puccinia Virgaureae* Lib. The Hon. Secretary and Mrs. E. A. Rea continued in the Forest over the week end and worked the portions further in the direction of Brockenhurst, and in the northern part around Minstead. These yielded *Lepiota clypeolaria* (Bull.) Fr., *Pholiota radicosa* (Bull.) Fr., *Cortinarius calochrous* (Pers.) Fr., *Cortinarius dibaphus* Fr. var. *xanthopyllus* Cke., *Stropharia squamosa* Fr. var. *aurantiaca* Cke., *Gomphidius maculatus* (Scop.) Fr., *Sparassis crispa* Fr., *Xylaria polymorpha* (Pers.) Grev. var. *pistillaris* Nke. Over five hundred species of fungi and fifteen mycetozoa were collected during the foray, and more than one hundred basidiomycetes are additions to the list of fungi of the New Forest published by Mr. J. F. Rayner in 1912. The Hon. Secretary has to thank Mr. A. D. Cotton, Mr. J. Ramsbottom, and Miss E. M. Wakefield for their kind assistance in preparing the subjoined list.

COMPLETE LIST OF FUNGI GATHERED DURING THE FORAY.

Species not generally distributed throughout the Forest are marked by letters indicating the direction from Lyndhurst, where the same were found, viz.: *B.* = Brockenhurst; *C.* = Christchurch; *E.* = Emery Down; *L.* = Lyndhurst Road railway station; *M.* = Minstead; and *R.* = North of racecourse.

Amanita verna (Lam.) Fr. (syn. virosa Fr.), *B.*, *C.*, *L.*, *M.*, phalloides (Vaill.) Fr., mappa Fr., porphyria (A. & S.) Fr., *B.*, *L.*, recutita Fr., *B.*, *L.*, *R.*, muscaria (Linn:) Fr., pantherina (DC.) Fr., excelsa Fr., *B.*, *E.*, rubescens (Pers.) Fr., spissa Fr.

Amanitopsis vaginata (Bull.) Roze, fulva (Schaeff.) W. G. Sm., nivalis (Grev.) Rea.

Lepiota rachodes (Vitt.) Fr., *C.*, amianthina (Scop.) Fr., *R.*, clypeolaria (Bull.) Fr., *B.*

Armillaria mellea (Vahl.) Fr., var. tabescens (Scop.) Rea & Ramsb., *L.*, mucida (Schrad.) Fr.

Tricholoma sejunctum (Sow.) Fr., B., L., spermaticum (Paul.) Fr., *C.*, flavo-brunneum Fr., albo-brunneum (Pers.) Fr., ustale Fr., *B.*, rutilans (Schaeff.) Fr., imbricatum Fr., *B.*, immundum Berk., *L.*, terreum (Schaeff.) Fr., *B.*, saponaceum Fr., *B.*, C., var. squamosum Cke., *B.*, cuneifolium Fr., *E.*, bufonium (Pers.) Fr., *B.*, carneum (Bull.) Fr., *C.*, album (Schaeff.) Fr., *B.*, acerbum (Bull.) Fr., *L.*

Clitocybe clavipes (Pers.) Fr., *B.*, *C.*, rivulosa (Pers.) Fr., *R.*, candicans (Pers.) Fr., *R.*, infundibuliformis (Schaeff.) Fr., *B.*, metachroa (Fr.) Berk., *C.*, ditopus Fr., *B.*, *L.*, fragrans (Sow.) Fr., *B. C.*

Laccaria laccata (Scop.) B. & Br., var. amethystina (Vaill.) B. & Br.

Collybia radicata (Relh.) Berk., *B.*, *C.*, platyphylla (Pers.) Fr.,*C.*, *L.*, fusipes (Bull.) Berk., lancipes Fr., *C.*, maculata (A. & S.) Fr., distorta Fr., *R.*, butyracea (Bull.) Fr., leucomyosotis Cke. & W. G. S., *L.*, confluens (Pers.) Fr., *C.*, tuberosa (Bull.) Fr., *C.*, *L.*, dryophila (Bull.) Fr., aquosa (Bull.) Fr., *C.*, *L.*

Mycena Iris Berk., *L.*, olivaceo-marginata Massee, *E.*, pura

(Pers.) Fr., flavo-alba Fr., *R.*, rugosa Fr., galericulata (Scop.) Fr., alcalina Fr., *B.*, *E.*, ammoniaca Fr., *B.*, *L.*, *R.*, metata Fr., *L.*, plicosa Fr., *R.*, plumbea Fr., *C.*, *L.*, vitilis Fr., *E.*, *L.*, haematopus (Pers.) Fr., C., sanguinolenta (A. & S.) Fr., galopus (Pers.) Fr., var. nigra Fl. D. (syn. leucogalus Cke.), *C.*, *L.*, epipterygia (Scop.) Fr., rorida Fr., *B.*, *L.*, *M.*, stylobates (Pers.) Fr., *B.*, *L.*, corticola (Schum.) Fr., *B.*

Omphalia philonotis (Lasch) Fr., *B.*, fibula (Bull.) Fr., var. Swartzii Fr., *B.*, var. nivalis (Fl. Dan.) Maire, *B.*, *L.*

Pleurotus ostreatus (Jacq.) Fr., *L.*, acerosus Fr., *B.*

Hygrophorus eburneus (Bull.) Fr., *B.*, cossus (Sow.) Fr., *B.*, *C.*, *E.*, pratensis (Pers.) Fr., *C.*, laetus (Pers.) Fr., *B.*, ceraceus (Wulf.) Fr., *L.*, coccineus (Schaeff.) Fr., *C.*, miniatus Fr., Reai Maire, *C.*, turundus Fr., *E.*, conicus (Scop.) Fr., chlorophanus Fr., *C.*, psittacinus (Schaeff.) Fr., unguinosus Fr., *B.*, *C.*

Lactarius turpis (Weinm.) Fr., torminosus (Schaeff.) Fr., pubescens Fr., *B.*, insulsus Fr., *B.*, blennius Fr., uvidus Fr., *B.*, *E.*, pyrogalus (Bull.) Fr., *C.*, chrysorheus Fr., *B.*, *L.*, piperatus (Scop.) Fr., *L.*, vellereus Fr., deliciosus (Linn.) Fr., pallidus (Pers.) Fr., *C.*, quietus Fr., aurantiacus (Fl. Dan.) Fr., *B.*, vietus Fr., *C.*, *L.*, rufus (Scop.) Fr., *C.*, *L.*, *M.*, helvus Fr., *B.*, glyciosmus Fr., *B.*, *L.*, fuliginosus Fr., picinus Fr., *B.*, lilacinus (Lasch.) Fr., *L.*, volemus Fr., *L.*, serifluus (DC.) Fr., *B.*, *L.*, mitissimus Fr., *L.*, subdulcis (Pers.) Fr.

Russula nigricans (Bull.) Fr., adusta (Pers.) Fr., densifolia (Secr.) Gill., *B.*, *L.*, delica Fr., L., chloroides (Krombh.) Bres., *B.*, *C.*, *L.*, mustelina Fr., *B.*, furcata (Pers.) Fr., *B.*, *C.*, *M.*, rosacea (Pers.) Fr., *B.*, atropurpurea (Krombh.) Maire, *B.*, caerulea (Pers.) Fr., *L.*, drimeia Cke., *C.*, *L.*, lactea (Pers.) Fr., *L.*, incarnata Quél., *L.*, virescens (Schaeff.) Fr., *B.*, *L.*, lepida Fr., *B.*, *C.*, *L.*, *M.*, xerampelina (Schaeff.) Fr., *C.*, *L.*, *M.*, *R.*, vesca Fr., *B.*, *C.*, *L.*, *M.*, *R.*, cyanoxantha (Schaeff.) Fr., consobrina Fr., *C.*, *L.*, foetens (Pers.) Fr., *B.*, *L.*, fellea Fr., emetica (Schaeff.) Fr., *C.*, fallax (Schaeff.) Fr., *B.*, *C.*, *M.*, azurea Bres., *L.*, ochroleuca (Pers.) Fr., citrina Gill., *B.*, *R.*, fragilis (Pers.) Fr., var. nivea (Pers.) Cke., *B.*, *L.*, violacea Quél., *B.*, *L.*, punctata (Gill.) Maire, *B.*, *S.*, var. violeipes (Quél.) Maire, *B.*, veternosa Fr., *L.*, integra (Linn.) Fr., *B.*, aurata (With.) Fr., *E.*, puellaris Fr., *B.*, *C.*, alutacea (Pers.) Fr., *E.*, *L.*, armeniaca Cke., *L.*, *M.*, lutea (Huds.) Fr., *B.*, *L.*

Cantharellus cibarius Fr., aurantiacus (Wulf.) Fr., *B.*, tubaeformis Fr., *B.*, *R.*

Craterellus cornucopioides (Linn.) Fr., *C.*, sinuosus Fr.,*B.*

Nyctalis parasitica (Bull.) Fr., *L.*

Marasmius peronatus (Bull.) Fr., *B.*, porreus (Pers.) Fr., *L.*, *R.*, oreades (Bolt.) Fr., erythropus (Pers.) Fr., *B.*, ramealis (Bull.) Fr., rotula (Scop.) Fr., *B.*, *C.*, *L.*, androsaceus (Linn.) Fr., *B.*, *L.*, *M.*, epiphyllus (Pers.) Fr., *L.*, *M.*

Panus stypticus (Bull.) Fr.

Lenzites betulina (Linn.) Fr.

Pluteus cervinus (Schaeff.) Fr., *L.*

Entoloma sinuatum Fr., *C.*, *L.*, lividum *B.*, *C.*, *L.*, Bloxamii Berk., *B.*, jubatum Fr., *C.* rhodopolium Fr., *B.*, nidorosum Fr., *B.*, *L.*, speculum Fr., *B.*

Clitopilus prunulus (Scop.) Fr., *C.*, *L.*

Leptonia lampropus Fr., *C.*, *L.*, sericella (Fr.) Quél., *E.*, *L.*

Nolanea pascua Fr., proletaria Fr., *C.*

Claudopus variabilis (Pers.) W. G. Sm.

Pholiota radicosa (Bull.) Fr., *B.*, spectabilis Fr., *B.*, *C.*, *L.*, *M.*, *R.*, marginata (Batsch) Fr., *B.*, *L.*, mutabilis (Schaeff.) Fr., *B.*, *L.*

Inocybe cincinnata Fr., *B.*, *L.*, petiginosa (Fr.) Quél, *B.*, lanuginosa (Bull.) Fr., *B.*, pyriodora (Pers.) Fr., *C.*, rimosa (Bull.) Fr., *B.*, *C.*, *L.*, duriuscula Rea,*B.*, asterospora Quél, *B.*, *L.*, fulvella Bres., *B.*, *E.*, geophylla (Sow.) Fr., var. violacea Pat., trechispora Berk., *L.*

Hebeloma sinuosum Fr., C., fastibile Fr., glutinosum (Lindg.) Fr., testaceum (Batsch) Fr., *C.*, *L.*, mesophaeum Fr., *B.*, *L.*, *R.*, crustuliniforme (Bull.) Fr.

Flammula alnicola Fr., *L.*, flavida (Schaeff.) Fr., *L.*, sapinea Fr., *C.*, *L.*, *M.*

Naucoria cucumis (Pers.) Fr., *L.*, melinoides (Bull.) Fr., *L.*, *R.*, semiorbicularis (Bull.) Fr., *B.*, escharoides Fr., *E.*, *L.*

Galera tenera (Schaeff.) Fr., spartea Fr., *B.*, hypnorum (Schrank) Fr.

Tubaria furfuracea (Pers.) W. G. Sm., paludosa Fr., *B.*, *L.*, crobulus Fr., *L.*

Crepidotus alveolus (Lasch) Fr., *E.*, mollis (Schaeff.) Fr., *C.*, *L.*

Cortinarius (Phlegmacium) varius (Schaeff.) Fr., *B.*, *E.*, multiformis Fr., *B.*, *C.*, calochrous (Pers.) Fr., *B.*, caerulescens Fr., *B.*, *C.*, *L.*, purpurascens Fr., *B.*, *C.*, *L.*, subpurpurascens Fr., *C.*, dibaphus Fr., var. xanthophyllus

Cke., *B.*, fulgens (A. & S.) Fr., *B.*, orichalceus (Batsch) Fr., *B.*

(Myxacium) collinitus (Sow.) Fr., *B.*, *E.*, mucosus (Bull.) Fr., *C.*, elatior (Pers.) Fr., vibratilis Fr., *B.*

(Inoloma) alboviolaceus (Pers.) Fr., *L.*, bolaris (Pers.) Fr., *B.*, *L.*, pholideus Fr., *R.*

(Dermocybe) tabularis (Bull.) Fr., *B.*, caninus Fr., *B.*, anomalus Fr., *L.*, lepidopus Cke., *B.*, *L.*, *R.*, miltinus Fr., *B.*, *L.*, cinnamomeus (Linn.) Fr., *B.*, *L.*, var. croceus (Schaeff.) Fr., *R.*, semisanguineus Fr., *R.*, cotoneus Fr.,*B.*

(Telamonia) bulbosus (Sow.) Fr., *B.*, torvus Fr., *B.*, *L.*, armillatus Fr., *R.*, hinnuleus (Sow.) Fr., gentilis Fr., *B.*, *R.*, brunneus (Pers.) Fr., *B.*, *C.*, *L.*, periscelis Fr., *L.*, incisus (Pers.) Fr., *R.*, hemitrichus (Pers.) Fr., *B.*, *L.*, stemmatus Fr., *B.*, rigidus (Scop.) Fr., *B.*, *L.*, paleaceus (Weinm.) Fr., *B.*, *L.*

(Hydrocybe) castaneus (Bull.) Fr., *B.*, *C.*, dolabratus Fr., *L.*, leucopus (Bull.) Fr., *C.*, *L.*, decipiens (Pers.) Fr., *B.*, *C.*, *M.*, obtusus Fr., *R.*, acutus (Pers.) Fr., *C.*

Paxillus involutus (Batsch) Fr.

Psaliota purpurascens Cke., *L.*, campestris (Linn.) Fr., *L.*, comtula Fr., *B.*, *L.*

Stropharia aeruginosa (Curt.) Fr., inuncta Fr., *C.*, coronilla (Bull.) Fr., *B.*, squamosa Fr., *B.*, var. aurantiaca Cke., *B.*, merdaria Fr., *B.*, *L.*, semiglobata (Batsch) Fr.

Hypholoma sublateritium (Schaeff.) Fr., capnoides Fr., *C.*, *L.*, fasciculare (Huds.) Fr., velutinum (Pers.) Fr., *B.*, *L.*, appendiculatum (Bull.) Fr., *B.*, *L.*, pilulaeforme (Bull.) Fr., *B.*, hydrophilum (Bull.) Fr.

Psilocybe ericaea (Pers.) Fr., *B.*, *L.*, *M.*, subericaea Fr., *L.*, uda (Pers.) Fr., *L.*, semilanceata Fr., *B.*, *C.*, *L.*, foenisecii (Pers.) Fr., *C.*

Psathyra corrugis (Pers.) Fr., *C.*, *L.*, fibrillosa (Pers.) Fr., *B.*, *L.*

Bolbitius titubans (Bull.) Fr., *B.*, vitellinus (Pers.) Fr., *C.*

Coprinus comatus (Fl. Dan.) Fr., *C.*, atramentarius (Bull.) Fr., *C.*, *L.*, cinereus (Schaeff.) Fr., *B.*, *M.*, niveus (Pers.) Fr., micaceus (Bull.) Fr., radiatus (Bolt.) Fr., *L.*, plicatilis (Curt.) Fr., *C.*, *L.*

Panaeolus sphinctrinus Fr., *L.*, campanulatus (Linn.) Fr., papilionaceus (Bull.) Fr., *L.*

Anellaria separata (Linn.) Karst., *C.*, *L.*
Psathyrella gracilis (Pers.) Fr., *B.*, *C.*, atomata Fr., *B.*
Gomphidius roseus (Fr.) Quél., *C.*, *L.*, maculatus (Scop.) Fr., *B.*
Boletus luteus (Linn.) Fr., elegans (Schum.) Fr., granulatus (Linn.) Fr., *B.*, bovinus (Linn.) Fr., *C.*, *L.*, badius Fr., *L.*, piperatus (Bull.) Fr., *B.*, *L.*, variegatus (Swartz) Fr., *C.*, *L.*, chrysenteron (Bull.) Fr., subtomentosus (Linn.) Fr., *B.*, *C.*, calopus Fr., *L.*, edulis (Bull.) Fr., reticulatus (Schaeff.) Boud., *L.*, luridus (Schaeff.) Fr., *B.*, *C.*, var. erythropus (Pers.) Fr., *R.*, viscidus (Linn.) Fr., *B.*, *C.*, *L.*, versipellis Fr., scaber (Bull.) Fr.
Fistulina hepatica (Huds.) Fr., *C.*
Polyporus rufescens (Pers.) Fr., *B.*, *E.*, squamosus (Huds.) Fr., *C.*, giganteus (Pers.) Fr., *C.*, lacteus Fr., *B.*, caesius (Schrad.) Fr., *C.*, *L.*, rutilans (Pers.) Fr., *C.*, adustus (Willd.) Fr., *L.*, amorphus Fr., *L.*, betulinus (Bull.) Fr.
Fomes applanatus (Pers.) Wallr., *L.*, resinaceus (Boud.) Rea, *B.*, nigricans Fr., *L.*, pomaceus (Pers.) Quél., *B.*, Ribis (Schum.) Fr., *B.*, annosus Fr., *B.*, *C.*, *L.*, ferruginosus (Fr.) Massee, *B.*
Polystictus perennis (Linn.) Fr., *L.*, versicolor (Linn.) Fr.
Poria mollusca (Pers.) Fr. *C.*, blepharistoma B. & Br. B.
Ptychogaster albus Cda., *B.*
Trametes rubescens (A. & S.) Fr., *L.*
Daedalea quercina (Linn.) Fr., *B.*, *C.*, *L.*
Merulius tremellosus (Schrad.) Fr., *C.*, corium Fr., *L.*
Phlebia merismoides Fr., *C.*
Hydnum repandum (Linn.) Fr., rufescens (Pers.) Fr., *L.*, cinereum (Bull.) Fr., *L.*, scrobiculatum Fr., L., udum Fr., *B.*, *L.*, farinaceum (Pers.) Fr., *B.*, *C.*, *L.*, fuscoatrum Fr., *B.*
Irpex obliquus (Schrad.) Fr.
Grandinia mucida Fr., *B.*, *C.*, helvetica Fr., *L.*
Sparassis crispa (Wulf.) Fr., *M.*, laminosa Fr., *L.*, *M.*
Thelephora laciniata (Pers.) Fr., *C.*, *L.*
Stereum hirsutum (Willd.) Fr., purpureum (Pers.) Fr., *B.*, sanguinolentum (A. & S.) Fr., *C.*, *M.*, spadiceum (Pers.) Fr., *L.*
Hymenochaete rubiginosa (Schrad.) Lév., *C.*, corrugata Lév., *B.*
Corticium praetermissum (Karst.) Bres., *B.*, *L.*, porosum B. & Br., *L.*, sulphureum (Pers. non Fr.) Bres. (= Phlebia vaga Fr.) *L.*, comedens Fr., *L.*, confine Bourd. & Galz., *C.*

Peniophora quercina (Pers.) Cke. *B.*, *L.*, cinerea (Fr.) Cke., *B.*, *L.*, aurantiaca Bres., *L.*, setigera (Fr.) Bres., *L.*
Hypochnus caesius (Pers.) Wakef., *B.*, fuscus (Pers.) Karst., *B.*, *L.*, botryoides* (Schw.) Burt (new to Britain), cinerascens* Karst., *L.* (new to Britain), ferrugineus (Pers.) Fr., *L.*, zygodesmoides† (Ell.) Burt, *B.* (new to Britain), subfuscus Karst., *B.*
Solenia anomala (Pers.) Fr., *B.*, *C.*, *L.*
Clavaria flava (Schaeff.) Fr., *E.*, botrytis (Pers.) Fr., *R.*, cinerea (Bull.) Fr., *B.*, cristata (Holmsk.) Fr., *B.*, rugosa (Bull.) Fr., *C.*, formosa (Pers.) Fr., *B.*, *E.*, flaccida Fr., *L.*, luteo-alba Rea, *R.*, dissipabilis Britz., *B.*, *L.*, vermicularis (Scop.) Fr., *L.*, acuta (Sow.) Fr., *C.*
Typhula erythropus (Bolt.) Fr., *B.*
Sebacina incrustans Tul., *L.*
Femsjonia luteo-alba Fr., *B.*, *L.*
Tremella mesenterica (Retz.) Fr., *C.*, albida (Huds.) Fr., *B.*, *L.*
Dacryomyces deliquescens (Bull.) Duby, *L.*, stillatus (Nees) Fr., *C.*, *E.*, *M.*
Calocera cornea (Batsch) Fr., *L.*, stricta Fr., *L.*, viscosa (Pers.) Fr., *C.*, *L.*, *R.*
Mutinus caninus (Huds.) Fr., *B.*, *R.*
Sphaerobolus stellatus (Tode) Pers., *B.*
Cyathus vernicosus (Bull.) DC., *C.*
Crucibulum vulgare Tul., *L.*
Bovista plumbea Pers., *C.*, *L.*, nigrescens Pers., *C.*
Lycoperdon perlatum Pers., depressum Bon., *L.*, pyriforme (Schaeff.) Pers., umbrinum Pers., *L.*, *R.*, saccatum (Vahl.) Fr., *E.*, *L.*
Scleroderma vulgare Hornem., *L.*, verrucosum (Bull.) Pers., *C.*
Rhizopogon luteolus Fr., *B.*, rubescens Tul., B., L.
Uromyces Betae (Pers.) Tul., *Lyndhurst, on Mangel.*
Puccinia Violae (Schum.) DC., *L.*, obtegens (Link) Tul., *B.*, Leontodontis Jacky, *L.*, Menthae Pers., *B.*, *L.*
Triphragmium Ulmariae (Schum.) Link, *B.*
Phragmidium mucronatum Schlecht., *B.*, violaceum (Schultz) Wint., *B.*, *L.*
Coleosporium Sonchi Lév., *B.*
Melampsora Hypericorum (DC.) Schröt., *L.*, Larici-Epitea Kleb., *L.*, *on Salix.*
Melampsoridium betulinum (Pers.) Kleb.
Urocystis Anemones (Pers.) Wint., *L.*, *on Ranunculus.*

* See description, p. 477.
† See description, p. 476.

Sphacelotheca Hydropiperis (Schum.) de Bary, *B.*, *L.*
Ustilago flosculorum (DC.) Wint., *E.*, *on Scabiosa succisa.*
Sphaerotheca pannosa (Wallr.) Lév., *L.*, humuli, *Lyndhurst, on Fragaria vesca.*
Podosphaera leucotricha, *Lyndhurst, on Pyrus Malus.*
Erysiphe communis (Wallr.) Fr., *L.*
Uncinula Aceris (DC.) Sacc., *B.*
Nectria cinnabarina (Tode) Fr., *C.*, episphaeria (Tode) Fr., *C.*, coccinea (Pers.) Fr., *M.*
Hypomyces rosellus (A. & S.) Tul., *L.*
Epichloe typhina (Pers.) Tul., *C.*
Claviceps microcephala (Wallr.) Tul., *L.*
Cordyceps militaris (Linn.) Link, *L.*
Eutypa lata Tul., *C.*
Sphaerella Fragariae (Tul.) Sacc., *Lyndhurst,* Elodes A. L. Sm. & Ramsb.
Mycosphaerella brassicola (Duby), *Lyndhurst.*
Melanconis stilbostoma (Fr.) Tul., *B.*
Diatrypella quercina (Pers.) Nke., *B.*
Diatrype stigma (Hoffm.) de Not., *L.*, *M.*, disciformis (Hoffm.) Fr., *B.*
Hypoxylon multiforme Fr., *C.*, fuscum (Pers.) Fr., *C.*, coccineum (Bull.) Fckl., *B.*, *C.*
Botryosphaeria Dothidea (Moug.) Ces. & de Not., *C.*, *on Rosa.*
Ustulina vulgaris Tul., *B.*, *C.*
Xylaria hypoxylon (Linn.), polymorpha (Pers.) Grev. var. pistillaris Nke., *B.*
Phyllachora Graminis (Pers.) Fckl., *B.*, Junci (Fr.) Fckl., *L.*
Rhopographus Pteridis (Sow.) Wint., *L.*, *M.*
Macropodia macropus (Pers.) Fuck. *B.*
Aleuria ampliata (Pers.) Gill., *C.*
Otidea onotica (Pers.) Fuck., *B.*
Peziza aurantia Pers., *B.*, *L.*
Lachnea hemisphaerica (Wigg.) Gill., *C.*
Ciliaria scutellata (Linn.) Quél., *L.*
Cheilymenia stercorea (Pers.) Boud., *C.*, coprinaria (Cke.) Boud., *L.*
Coprobia granulata (Bull.) Boud., *B.*, *L.*
Ascobolus stercorarius (Bull.) Schröt. (syn. furfuraceus), *B.*, *L.*, viridulus Phill. & Plowr.
Leotia lubrica (Scop.) Pers., *E.*
Calycella citrina (Hedw.) Quél., *L.*
Coryne sarcoides (Jacq.) Tul., *B.*
Bulgaria inquinans (Pers.) Fr., *C.*
Orbilia leucostigma Fr., *L.*, xanthostigma Fr., *B.*, *C.*, *L.*, *R.*, curvatispora Boud.

Sclerotinia Curreyana (Berk.) Karst., *L.* (=*Sclerotium roseum* Fr.)
Phialea firma (Pers.) Gill., *B.*
Chlorosplenium aeruginosum (Oeder) de Not., *B.*, *L.*
Helotium fructigenum (Bull.) Fuck., *L.*, virgultorum (Wahl.) Karst., *C.*
Dasyscypha virginea (Batsch) Fuck., *B.*, ciliaris (Schrad.) Sacc., *L.*, fuscescens (Pers.) Rehm., *L.*
Trichoscypha calycina (Schum.) Boud., *C.*, *M.*
Mollisia cinerea (Batsch) Karst., *B.*, *L.*, melaleuca (Fr.) Sacc., *R.*
Propolis faginea (Schrad.) Karst., *C.*
Stegia Ilicis Fr., *B.*, *C.*, *L.*
Rhytisma acerinum (Pers.) Fr., *L.*
Pilobolus crystallinus (Wiggers) Coem., *L.*, longipes van Tiegh.
Phytophthora infestans (Mont.) de Bary, *Lyndhurst, on Solanum tuberosum and S. Lycopersicum.*
Peronospora cubensis B. & C., *Lyndhurst, on Cucumis.*
Synchytrium endobioticum. *Allotments, Lyndhurst, near the "Crown and Stirrup" Inn, on Solanum tuberosum (H. V. Taylor).*
Phyllosticta ruscicola, Dur. & Mont., *B.*
Phoma conigena Karst., *L.*, Myricae Karst., *L.*, destructiva Plow., *Lyndhurst, on Solanum Lycopersicum,* numularis.
Ascochyta Armoraciae Fuck.
Actinonema Rosae (Lib.) Fr., *Lyndhurst.*
Septoria Fragariae Desm., *B.*, Rubi Westend, *L.*, Violae Westend, *L.*
Oidium alphitoides Griff. & Maulb., *B.*, *L.*
Ovularia obliqua (Cke.) Lindau, *L.*, *on Rumex,* primulana Karst.
Sepedonium chrysospermum (Bull.) Fr., *B.*, *C.*, *L.*
Ramularia Ajugae (Niessl.) Sacc. *L.*, Cardui Karst., *B.*, Taraxaci Karst.
Bispora monilioides Cda., *B.*
Heterosporium epimyces Cke. & Massee, *B.*
Macrosporium Solani Cke., *Lyndhurst.*
Aegerita candida Pers., *L.*
Fusarium Solani Mart., *Lyndhurst.*

*Mycetozoa.**

Badhamia foliicola Lister. Developed from yellow plasmodium. Verified by Miss Lister.
Physarum nutans Pers., *L.*

* Dr. W. T. Elliott, F.Z.S., F.L.S., kindly furnished me with this list.

Fuligo septica (L.) Gmel., *B.*
Stemonitis fusca Roth., flavogenita Jahn, developed from plasmodium.
Comatricha nigra (Pers.) Schröt.
Cribraria pyriformis Schrad., developed from rotten wood brought from Lyndhurst.
Dictydium cancellatum (Batsch) Macbr., var. fuscum Lister.
Recticularia Lycoperdon Bull., *L.*
Lycogala epidendrum (L.) Fr., *L.*
Trichia decipiens (Pers.) Macbr., *L.*
Arcyria cinerea (Bull.) Pers., *L.*, pomiformis (Leers) Rost., developed from plasmodium, denudata (L.) Sheldon, incarnata Pers., *L.*

OBSERVATIONS UPON THE EDIBILITY OF FUNGI FOR RODENTS.

By Somerville Hastings, M.S. (Lond.), F.R.C.S. (Eng.), and J. C. Mottram, M.B. (Lond.)

Evidence has been collected which shows that certain species of fungi form the natural food of wild animals more especially Rodents. This evidence is laid out under three headings: I.—Collected Literature; II.—Field Observations; and III.—Feeding Experiments upon Squirrels and Rabbits.

I. Literature.

A Correspondent.—"The Country Life," September, 1913:—

"I might say that in the summer of 1910 I observed a squirrel eating a dark species of toadstool. The little animal was sitting on an oak tree, nibbling at something. A moment later it let fall the remains, which proved to be the stalk of a toadstool. It then descended the tree, ran to a spot where a number of toadstools grew, picked one up, and returned to the oak. The stalk was again dropped."

Sir Charles Langham, Bart.—"The Irish Naturalist," Vol. XXV., No. 8, Aug., 1916, p. 136.—

"Squirrel eating *Melanogaster ambiguus*. On the 20th June last, I watched a squirrel for some time digging in the grass on the lawn here, and greedily eating what it had found. After a time, I went out and investigated and discovered a half-eaten fungus, which was growing about three inches underground. It had the most awful smell, and I wondered how any animal could eat such a disgusting thing. I sent it up to Miss Knowles of the National Museum, and she very kindly informed me that it was *Melanogaster ambiguus*, and that it had not hitherto been reported from Ireland."

Tempo Manor, Co., Fermanagh.

George Massee, "British Fungi and Lichens," London, 1913, figures a specimen of *Boletus scaber,* "showing tooth-marks of a squirrel," but gives no further details.

Russ, M., and Fisch, C.—"Untersuchungen unter Bau und Lebensgeschichte der Hirschtrüffel, Elaphomyces," "Bibliotheca Botanica," 1887,—believe that the spores of Elaphomyces are distributed mainly by the help of wild animals at all times of the year. Spores pass unchanged through the alimentary canals of both wild and experimental animals, but all attempts to make these spores germinate have failed. No signs of growth are observed even after five years both in soil and in the open air and a similar result has followed the treatment of the spores with various decoctions and ferments.

Du Reau, L.—"Bulletin de la Société des Sciences naturelles de l'ouest de la France," 3me série, Tome II., 1912, —finds that *Balsamia vulgaris* (Vitt.) is dug up and eaten by squirrels in Anjou. It is probably the nutty smell which the fungus acquires with age rather than its nutritive value that attracts the squirrels.

M. C. Cooke, "Grevillea," Vol. XIX., (1890-91), page 54:—

"Animal Mycophagists.—The late Mr. James English, of Epping, who was a shrewd observer and a constant visitor in Epping Forest, at all seasons of the year, has often called attention to the fact that squirrels, which are plentiful in the forest, were very fond of eating the tops of the large species of *Boletus*. We have in his company witnessed them in the enjoyment of their feast. The bright yellow, pine-loving species are very rare there and hence were exempt, as well as the poisonous species of the *luridus* group, but we fancy it to have been *B. pachypus* and *B. impolitus* which were the greatest sufferers."

A Correspondent.—"Science Gossip," Vol. I., February 1st, 1865, page 40:—

"Walking in the pleasure grounds of my house in Warwickshire one morning in September some years ago, I noticed a tall well grown toadstool springing up from the grass in a grove of trees. Being perfectly ignorant of Fungi I can only say that this one was white throughout and in shape like a well expanded Mushroom on a taller stem. A little squirrel descended from one of the trees and made straight for the toadstool and without noticing me felled it in the neatest and most workman-like manner by biting through its stem close to the ground; then, taking it in its mouth by the stem, he ran up the tree from which he had descended and having found a convenient seat, proceeded to eat the toadstool with much apparent satisfaction. A friend of mine has since told me that he has witnessed a similar incident in his own garden in Staffordshire, but I do not know if the toadstool chosen by *his* squirrel was of a similar kind."

Miss G. Lister in a letter in September, 1916, wrote: "I have watched a squirrel eating a *Tricholoma,* I think it may have been *terreum*—in just the way you describe—a very pretty sight. I have also watched a rabbit eating *Amanita rubescens* in our forest, while we were waiting for badgers in the dusk."

Mr. Hugh Main, B.Sc., in a letter, December, 1916, wrote: "I once saw a squirrel crossing a road with a puff-ball in its mouth and it dropped it in its hurry."

At the Annual Meeting of the British Mycological Society at Lyndhurst in 1916, *Mr. Carleton Rea* mentioned that horses and sheep frequently eat *Agaricus campestris. Mr. C. J. Sharpe* said that he had once watched a mouse eating a species of Russula, while *Dr. J. S. Bayliss-Elliott* reported that she had watched a squirrel eating *Russula ochroleuca,* a robin pecking at *Agaricus campestris* at the end of August or beginning of September, and blackbirds and thrushes constantly pecking at *Hypholoma sublateritium* in September and October.

II. Field Observations.

In September 1913, one of us was walking in some woods a few miles from Vienna, when a toadstool, a species of Flammula, which grows on the ground, suddenly fell at his feet. The cap of the toadstool was broken, perhaps, by its fall, but the stalk was still attached to it. On looking round to see whence the toadstool had come, a little brown squirrel was seen sitting on the branch of a tree immediately overhead. Although no toothmarks were seen in the toadstool, there

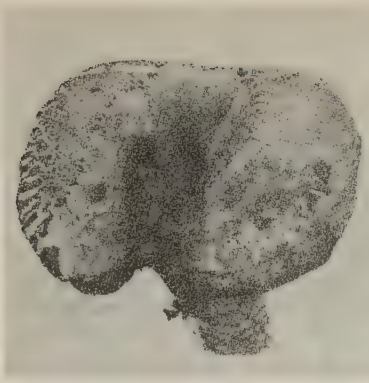

FIGURE 1.
Boletus chrysenteron, showing toothmarks of a rodent. × ⅔.

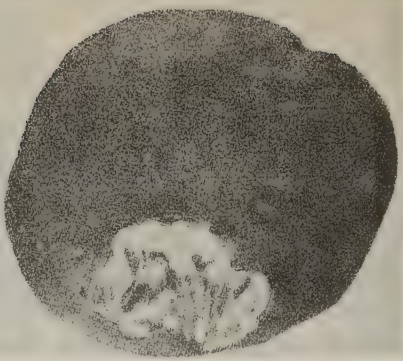

FIGURE 2.
Boletus badius, showing tooth-marks of a rodent. × ⅔.

FIGURE 3.
Boletus badius. Sampled but not approved by a rodent.

FIGURE 4.
Paxillus involutus. Several caps are partly eaten by rodents.

The blocks illustrating this paper (figs. 1-11) were kindly lent to the Society by the proprietors and editor of "Knowledge."

appeared to be no doubt that it had been dropped by the squirrel.

In Epping Forest, Byfleet, and Oxshott Woods we have found specimens of *Boletus edulis, Boletus badius* (see Figures 2 and 3) *Boletus chrysenteron* (see Figure 1.) *Boletus flavidus, Boletus variegatus, Cortinarius collinitus* and *Lactarius turpis,* all showing undoubted tooth-marks of a small rodent. All these were found in summer and early autumn, and in some cases the greater part of a large specimen, weighing two or three ounces, had been eaten. In at least three cases, in which a fairly large fungus had been attacked, two little holes, one on each side of the area that had been most eaten, were seen. These were clearly produced by the pressure of the front paws of a small animal; they can be made out rather indistinctly in Figure 1. We have also found, in July, a specimen of *Paxillus atrotomentosus,* showing undoubted tooth-marks. All the fungi so far mentioned are relatively large and succulent, and tooth-marks are easily seen in them. Although there is evidence that many of the smaller and more fibrous toadstools are also eaten by rodents, tooth-marks are much more rarely found. From these last small pieces seem to be seized and torn off, whereas the larger and more succulent are eaten very much as a boy eats an apple.

The fungi so far described were all eaten in the late summer and early autumn. As the year advances, other specimens become attacked. *Hygrophorus hypothejus* (see Figure 5) is a very common fungus in Oxshott Woods. It grows in groups, and from the middle of November to the end of December is very much eaten. In some specimens definite tooth-marks are to be seen, but most appear to have been bitten through at the highest part of the stalk, the caps turned over, and the gills nibbled as they lay on the ground. *Paxillus involutus* (see Figure 4) was also eaten pretty extensively at Oxshott about the middle of November, and several specimens of *Boletus variegatus* were found much eaten, and showing definite tooth-marks about this time.

But except for *Hygrophorus hypothejus* and *Paxillus involutus* it is not until the frosts begin, and the ground becomes hard and food scarce, that many different fungi are eaten. During November and December it would seem that fungi must form a very important article of diet for rodents. On November 28th, 1915, every species of toadstool found growing in Oxshott Woods, except *Flammula sapinea* and *Fomes annosus,* showed tooth-marks of small rodents. The species eaten were as follows:—

Hygrophorus hypothejus (see Figure 5).—More than half

the specimens nibbled, and many almost completely eaten.

Paxillus involutus (see Figure 4).—Over half the specimens nibbled, but very few much eaten.

Cantharellus aurantiacus.—About a quarter of the specimens eaten, and several almost completely.

Lactarius rufus (see Figure 6).—Perhaps a quarter nibbled, but very few much eaten.

Russula emetica (see Figure 9).—About one-sixth of the specimens seen were eaten, but none very much.

Boletus variegatus.—A few eaten.

Boletus badius.—A few eaten.

Tricholoma terreum.—A few eaten.

Elaphomyces granulatus.—A few eaten.

Boletus bovinus.—A very few eaten.

Clitocybe brumalis.—A very few eaten.

Collybia maculata.—A very few eaten.

In some specimens of each of the above species definite tooth-marks were seen, such as could not possibly have been made by slugs, which are well known to eat fungi extensively. In some species, such as *Boleti*, every specimen eaten showed tooth-marks; in others of a more fibrous nature, such as *Paxillus involutus* (see Figure 4), tooth-marks were only seen in a very few. One specimen of the poisonous Fly Agaric (*Amanita muscaria*) showed a tooth-mark. It had evidently been tried, but not approved of.

It is quite possible that even more fungi than those included above are eaten by rodents, for a completely devoured fungus leaves no record. In early autumn at Oxshott we found many swollen white bases of an Agaric of some size, but whether these had been eaten by rodents or not it was impossible to determine.

Only one fungus which grows on trees, *Polyporus betulinus* (see Figure 8) has been found with tooth-marks on it. This specimen was, however, growing on a fallen tree, and the tooth-marks, from their size, appear to be those of a rabbit.

III. Feeding Experiments on Squirrels and Rabbits.

In order to substantiate the above field observations, a few simple feeding experiments were carried out to see whether squirrels will eat fungi. The grey American squirrel (*Sciurus cinereus*) was used. The animals were quite tame, fed from the hand, and were at large during the day. Food was given to them regularly, and consisted chiefly of nuts. Any excess of food is buried by them in the ground for future use; but it cannot be recovered when the ground is frost-bound. This has a bearing on the feeding experiments, for it was found that on a frosty morning, when this supply

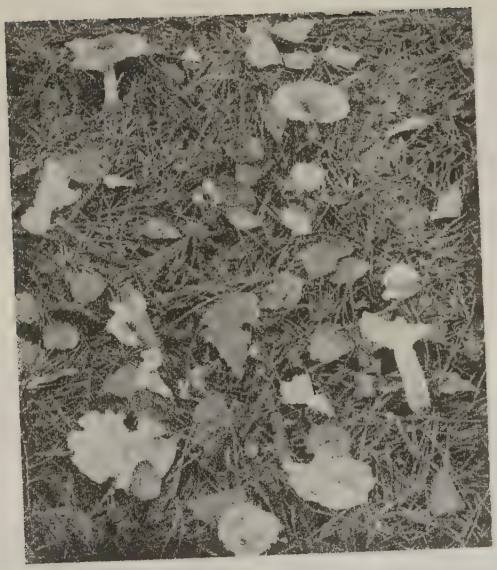

FIGURE 5.

Hygrophorus hypothejus, with caps removed, partly eaten by rodents.

FIGURE 6.

Lactarius rufus nibbled by rodents.

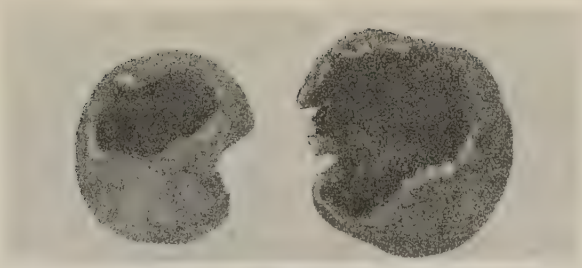

FIGURE 7.
Two specimens of ***Elaphomyces granulatus*** found partially eaten in burrows.

FIGURE 8.
Polyporus betulinus, showing tooth-marks probably of a rabbit.

FIGURE 9.
Russula emetica, partly eaten by rodents.

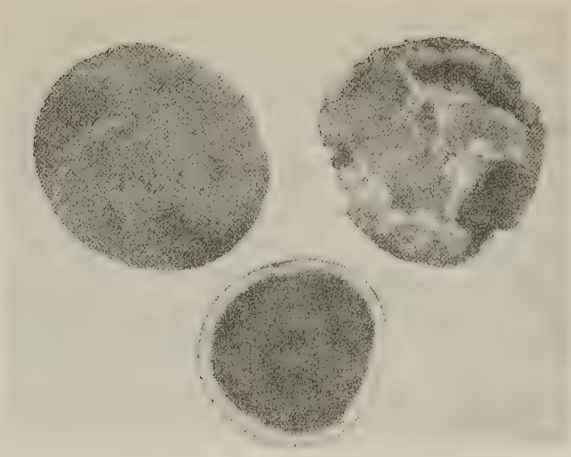

FIGURE 10.

Elaphomyces granulatus. One specimen photographed from above, another in section, and a third nibbled and showing tooth-marks. × 3/2.

FIGURE 11.

Elaphomyces granulatus, showing tooth-marks in burrows made by some small animal.

was cut off, the animals had a hearty appetite, and accepted fungi which at other times were refused. Only small pieces of fungus were given, and these were treated by the animals in one of three ways: (1) They were taken in the fore-paws, quickly brought in front of the nose, then dropped. This is called refusal in the following tables (R). (2) They were taken in the fore-paws, brought to the nose, put into the mouth, and then broken into pieces by the incisor teeth. In doing this the tip of the tongue comes into contact with the pieces, and there is no doubt that the animals are tasting the food. In the experiments this is called nibbled (N). (3) They were broken into pieces by the front teeth, passed back to the molars, crushed, and finally swallowed. This is called eaten (E).

Table 1.

Fungus.	Animals.					
	A	B	C	D	E	F
Amanita muscaria	E_1	E_5	R_4	R_3	E_1	N_1
Russula emetica	R_2	R_1	N_5	N_4	E_2	
Hygrophorus hypothejus ...	N_3	N_2	E_1			
Collybia maculata	N_4	N_3	N_2	R_1	R_3	
Flammula sapinea	N_6	N_4	R_3	R_2		

The ground was soft.

Table 2.

Fungus.	Animals.			
	A	B	C	D
Paxillus involutus	N_1	R_2	R_3	R_2
Cantharellus aurantiacus	R_2	N_1	R_2	N_1
Clitocybe brumalis	R_3	R_3	N_1	R_3

The ground was soft.

TABLE 3.

Fungus.	Animals.					
	A	B	C	D	E	F
Collybia maculata	R_1	R_1	E	N_2	E_3	N_3
Cantharellus aurantiacus ...	R_2	N_3		N_1	R_2	R_2
Paxillus involutus	R_3	R_2		R_3	R_1	R_1

The ground was soft.

TABLE 4.

Fungus.	Animals.				
	A	B	C	D	E
Amanita muscaria	R_1	E_1	R_2	E_1	E_2
Hygrophorus hypothejus	R_2	N_2	N_1	N_2	E_1
Lactarius rufus	R_3	N_3	R_3		

The ground was soft.

TABLE 5.

Fungus.	Animals.							
	A	B	C	D	E	F	G	H
Hygrophorus hypothejus ...	N_1	E_1	E_3	E_4	N_3	E_5	R_4	R_1
Paxillus involutus	E_2	N_2	N_1	N_5	N_4	E_4	E_5	
Elaphomyces granulatus ..	N_3	N_3	N_2	N_1	R_5	N_3	R_1	
Boletus variegatus	N_4	N_4	E_3	E_2	N_1	E_2	E_2	
Boletus bovinus	R_5	R_5	R_4	N_3	N_2	E_1	E_3	

The ground was frozen.

Table 6.

Fungus.	Animals.				
	A	B	C	D	E
Collybia maculata	E_1	E_3	N_2	E_1	N_3
Paxillus involutus	E_2	N_2	N_3	N_2	E_1
Hygrophorus hypothejus	E_3	E_1	E_1	E_3	E_2

The ground was frozen.

The preceding six tables give the experimental data. The first column gives the fungi; ten species were used. Of the other columns, each deals with a single animal, marked at the column heads, A, B, C, D, and so on. The letters in these columns indicate whether the fungus was refused, nibbled, or eaten. The subscript figures represent the order in which the fungi were given. Beneath each table a note is made as to whether the ground was frost-bound or not. The tables show that several fungi, which had been repeatedly refused on warm mornings when the animals were not very hungry, were eaten on frosty mornings when their appetites were keen. Field observations are in keeping with this finding, for in the early frosts of winter many fungi were found eaten which before had not been touched. Eight species of fungi were tested on frosty mornings; only one, *Elaphomyces granulatus*, was not eaten. It was nibbled on two occasions; but directly the black dry spores within were exposed, the fungus was dropped. The specimens of Elaphomyces used in the experiments were rather dry, and the outer covering was hard; this might account for it being refused. It is noteworthy that in five out of seven cases it was nibbled. The experiments also show that fungi poisonous to man are not unpalatable to squirrels. It can be seen that *Amanita muscaria* was eaten on six occasions, *Russula emetica* once. It is noteworthy, however, that the American squirrel was used, and that therefore neither the animals nor their ancestors can have had much experience of English fungi. The experiments show that squirrels will eat fungi of their own free choice, even when other food is available.

Similar experiments have also been carried out with Rabbits; two nearly full-grown animals were used, one of which was coloured grey, the other white with a few grey patches. They were fed regularly each day at 10. 0 a.m.

upon a mixed diet of greens, bran and oats. In the first series of tests, numerous species of fungi were offered between 11. 0 a.m. and 12. 0 mid-day, that is, soon after being fed: refusal was experienced on every occasion except with one species, namely *Paxillus involutus*.

In the second series, the fungi were given at 10. 0 a.m., the animals not having been fed since 10. 0 a.m. the previous day. Under these conditions, a good number of fungi were eagerly eaten, the majority were definitely refused and only a very few were nibbled before being rejected. A striking behaviour of the animals, was the immediate sureness of acceptance or refusal: on a fungus being offered, the animal would place its nose close to it and at once begin to eat, or at once turn away: on no occasion was a change of mind observed. Selection was made almost certainly with the sense of smell, only rarely was the sense of taste required for rejection.

In each experiment, from six to twelve species of fungi were used; whole specimens were offered in fresh condition, one after the other. When acceptance resulted, only a very small quantity was permitted to be eaten, in order not to disturb the animal's condition of appetite. After two or three refusals, a species of known acceptability was given as a control; more especially if nibbling had occurred, in order to, as it were, wash out the olfactory and gustatory sense organs. In each experiment, after the first offerings, the fungi were given in the reverse order and only on one or two occasions were differences noted, chiefly nibblings becoming refusals. The animals did not appear to use their eyes in the discriminations; no refusals on sight were made, but only after the fungi had been tested by smell. The only difference observed between the two animals, was that the grey one was somewhat quicker than the white, in deciding.

In a third series of experiments, the animals were starved for a period of 48 hours; in a number of cases, fungi which had been refused after 24 hours' starvation, were eaten after 48. The following table shows the results of a single experiment carried out along these lines.

TABLE 7.

24 Hrs.' Starvation.			48 Hrs.' Starvation.	
Grey Rabbit.	White Rabbit.	Fungus.	Grey Rabbit.	White Rabbit.
R	R	Clitocybe geotropa	R	R
E	E	Paxillus involutus	E	E
R	R	Polystictus perennis	Not tested.	
R	R	Hygrophorus hypothejus	R	E
R	R	Cantharellus tubaeformis	R	R
E	E	C. aurantiacus	E	E
R	R	Paxillus involutus (maggoty)	E	E
R	R	Cortinarius cinnamomeus	R	R
R	R	Russula drimeia	R	R
R	R	Clitocybe brumalis	E	R
R	R	Thelephora laciniata	R	R
E (once)	R	Sparassis crispa	R	R
E	E	Mycena epipterygia	E	E

R = refused. E = eaten.

42 species of fungi were tested. In the following list they are divided into groups, according to their palatability as ascertained by the experiments.

TABLE 8.

Group I.—Species refused after 48 hours starvation :—

Thelephora laciniata, Clitocybe geotropa, Cantharellus cibarius, Hypholoma fasciculare, Cantharellus tubaeformis, Lactarius rufus, Amanita muscaria, Amanita rubescens, Russula emetica, Lactarius turpis, Peziza aurantia, Leotia lubrica, Cortinarius cinnamomeus var. *semisanguineus, Russula drimeia.*

Group II.—Species refused after 24 hours starvation, not tested after 48 hours starvation :—

Polystictus perennis, Pholiota adiposa, Tremellodon gelatinosum, Calocera viscosa.

Group III.—Species refused after 24 hours starvation, nibbled after 48 hours starvation :—

Russula ochroleuca.

Group IV.—Species nibbled after 24 hours starvation, not tested after 48 hours starvation :—

Collybia maculata, Tricholoma terreum, Xylaria polymorpha.

Group V.—Species refused after 24 hours starvation, but eaten after 48 hours starvation :—

Clitocybe brumalis, Stereum hirsutum, Marasmius peronatus, Boletus luridus, B. versipellis, Polyporus giganteus, Lactarius subdulcis, Peziza badia, Hygrophorus hypothejus, Flammula sapinea, Sparassis crispa.

Group VI.—Species eaten after 24 hours starvation :—

Phallus impudicus, Scleroderma vulgare, Paxillus involutus, Cantharellus aurantiacus, Mycena epipterygia, Hydnum repandum, Tricholoma rutilans, Boletus badius, Elaphomyces granulatus.

Group VII.—Species eaten with usual diet :—

Paxillus involutus, and sometimes *Cantharellus aurantiacus.*

The list shows that tame rabbits will eat a good many species of fungi, when moderately hungry; this number increases with their hunger. The tooth-marks made during these experiments upon several species of fungi, more especially *Boletus badius,* corresponded exactly with those found under natural conditions.

The animals did not present any ill effect from the consumption of these fungi. On one occasion 13 specimens of *Paxillus involutus* were given the grey rabbit instead of the usual 10 o'clock feed. After 24 hours only three specimens could be found.

It is noteworthy that the preferences of rabbits are quite different from those found when squirrels were used; for instance, *Hygrophorus hypothejus* was readily eaten by a squirrel, but only after 48 hours starvation, by rabbits; and whereas *Paxillus involutus* was eaten by rabbits with their ordinary diet, it was refused by squirrels except when the ground was frozen when it was eaten on five occasions out of twelve, (see Tables 5 and 6). Squirrels will eat fungi when less hungry than rabbits.

In nature also it would seem that both squirrels and rabbits regularly eat fungi. Squirrels have been seen eating fungi on several occasions, as has already been reported. Among the sand dunes close to the sea shore a mile and a half east of Minehead in September 1916 we found a specimen of *Boletus flavidus* showing large tooth-marks. There were many rabbit burrows immediately around, but the only trees near were a group of half a dozen pines. No evidences of the presence of squirrels in the form of bitten cones was observed though all these trees had an exceptionally large number of cones on them. It seems very probable therefore that the tooth-marks were those of rabbits.

It is quite easy to distinguish the tooth-marks made by a rodent from those of a slug. In the case of the slug a series

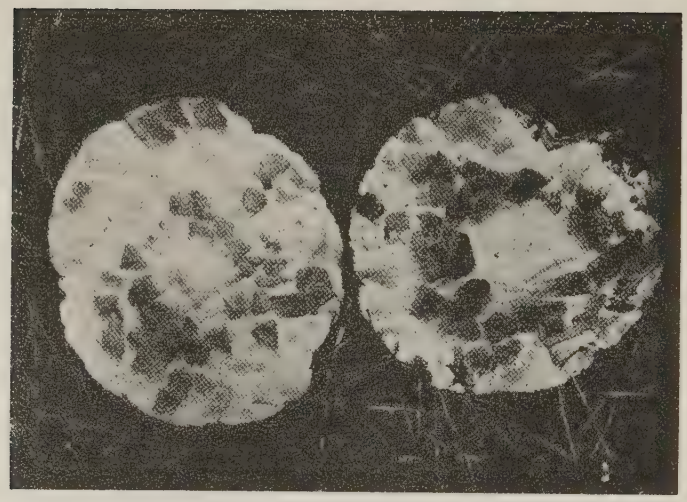

FIGURE 12.
Two specimens of *Boletus badius* eaten by rabbits.

of small oval or circular pieces appear to have been cleanly cut from the fungus. The teeth of rodents gouge out elongated pieces from the fungus and on it parallel lines produced by the cusps of the teeth can often be made out. The tooth-marks made by rabbits are larger than those of squirrels and from the size of the tooth-marks we are of opinion that in the late summer and early autumn most of the fungi are eaten by squirrels while in the late autumn rabbits are also responsible. Thus in October and November, 1916, we found a large number of half-eaten species of *Boletus badius* in Oxshott Woods (see Fig. 12). The fungi were broken off near the top of the stalk and laid pores downward on the ground. The flesh was then nibbled away systematically down to but not including the pores. The tooth-marks were identical with those of an experimental rabbit. There can be no doubt, however, that even late in the season some fungi are still eaten by squirrels, for during November and December *Hygrophorus hypothejus,* which has been shown experimentally to be much more palatable to squirrels than to rabbits showed only much smaller tooth-marks than those found in *Boletus badius.* Both experimental and field observations therefore agree in showing that in early autumn when food is plentiful squirrels are the chief depredators, while in late autumn rabbits add fungi to their diet. We have obtained no direct evidence that other rodents, mammals or birds eat fungi, but this possibility must not be overlooked.

Fungi appear to be eaten to some extent also by domestic animals. We watched a cow in the New Forest licking various species, but apparently refusing all but *Amanita rubescens,* which it swallowed greedily.

The false truffle (*Elaphomyces granulatus* (Figure 10)), which is fairly common in Oxshott Woods, is found at one to three inches below the surface of the ground, generally at the level of junction of the layer of leaf mould with the sandy soil of the Bagshot Sands, on which formation Oxshott Woods are situated. This false truffle is about the size and shape of a small walnut, but is somewhat flattened from above downwards. When ripe it consists of a hard leathery covering, about an eighth of an inch thick, enclosing a powdery mass of black spores. It has a faint earthy smell. In situations where the false truffle is likely to be found, numerous shallow burrows one to four inches deep, are seen throughout the whole year. We have seen no fewer than six or eight of these in as many square feet, and close by them are frequently to be seen the droppings of small animals, which correspond with those of squirrels and rabbits. On digging around the burrows, specimens of *Elaphomyces* are not infre-

quently found, and in the burrows round depressions were several times seen where, in all probability, these fungi once rested. Some burrows (see Figure 11) contained false truffles which had been nibbled, and many contained specimens which were half-eaten (see Figure 7). Beside another burrow was a specimen that had been fairly extensively eaten, and showed definite tooth-marks; another (see Figure 10), which was found some distance away from any burrow, showed these even better. On one occasion also we noticed a squirrel scratching and on digging around the burrow we found 5 specimens of *Elaphomyces*. Russ and Fisch have observed that specimens of *Elaphomyces* are dug up and eaten by wild animals at all times of the year, and Du Reau states that *Balsamia vulgaris,* an allied species, is excavated and eaten by squirrels. He thinks that it is the nut-like smell which the fungus acquires with age that is attractive to these animals. Du Reau further tells us that the scratchings made by squirrels are round, with the earth thrown out on all sides, while those made by rabbits are oval, and have the soil thrown out on one side only . At Oxshott both types of burrow are to be seen; and from the size of the tooth-marks it would appear that those specimens found eaten while still in the burrows have been attacked by rabbits (see Figure 7) while those which have been removed from the ground (Figure 10) have been sought for by squirrels. We have found that tame rabbits will readily eat *Elaphomyces,* and it has already been shown that squirrels also will take this fungus. In those fungi found extensively nibbled, hardly any of the powdery spores were removed. It is therefore probable that the outer covering only is palatable.

Lastly, it may be useful to inquire what advantage, if any, it is to a fungus to be eaten by animals. The spores of many fungi have been shown to pass unharmed through the alimentary canal of mammals. From the contents of the intestines of newly killed rabbits, extracted under conditions which make it impossible that any spores should have reached them from the air, many fungi have been grown. There is, indeed, a whole class of toadstools which grow exclusively on the dung of various herbivora. From the toadstools which are produced spores are shed, and are carried by the wind to fall on the grass or other vegetation whichs form the natural food of these animals. After passing through the alimentary canal the spores are deposited under ideal conditions for their germination and growth. Many species of toadstool, and particularly the gills of Agarics, are frequently eaten by slugs, and the germinating spores of *Russula* and *Lactarius* were found by Voglino* in the digestive tracts of slugs that were

* Nuovo Giornale Botanico, Vol. 27, 1895, pp. 181-188.

fed on these toadstools. Further, this observer showed that the spores of other species that would not germinate on ordinary culture media did so readily in the fluid from the digestive tract of a slug. The regular, and, so far as is known, sole method of spore dispersal in *Phallus*† is by means of flies, and here, again, it has been shown that the spores germinate well after passing through the alimentary canals of these insects. It is well known also that the edible truffles are eagerly sought after by pigs, and greedily devoured by them; and the fact that these fungi are only strong smelling when quite mature, and filled with ripe spores, suggests that this must be something of a co-operative arrangement, and that it is really to the interest of the fungus to be thus eaten. But most of the fungi that are eaten by small rodents are of the umbrella type, with gills or pores, a type which is so well adapted for the distribution of its spores by means of air-currents that it has become predominant in the fungus kingdom. Moreover, we have found that the toadstools are most eaten at the beginning of winter, when the bulk of the spores is shed, and, except in the case of *Hygrophorus hypothejus,* the gills or pores on which the spores are produced are generally less eaten than the rest of the pileus. It is probable, therefore, that any assistance that most fungi derive from animals in the distribution of the spores is of quite secondary importance.

With the false truffle (*Elaphomyces granulatus*) the case is, however, quite different. This fungus lies buried in the ground, and its spores are enclosed by a thick leathery cuticle which does not spontaneously rupture. *Scleroderma* resembles it closely, except that it grows on the surface of the soil, and in early autumn has its spores distributed by beetles, which eat their way into and through the fungus, and leave behind them, as indications of their work, a number of small holes in the lower part of the leathery coat. In *Elaphomyces* we have never seen such holes, and it is probable that the fungus is almost entirely dependent on small animals for the distribution of its spores. Russ and Fisch have found the spores of *Elaphomyces* unchanged in the excreta of wild animals, as well as those of animals fed experimentally on the fungus. They were unable, however, to induce the spores to germinate. When buried in the soil, and when left exposed to the air for as long as five years, they remained unchanged; nor did the employment of culture media of various decoctions and ferments give any better result.

† Annals of Botany, 1899-1900, p. 206.

Conclusions.—The above observations indicate that—

1. In early autumn, when food is plentiful, only a few specimens of fungi are eaten by rodents.
2. But in frosty weather, when food is more scarce, very many species are extensively eaten.
3. Squirrels and rabbits appear to be the rodents which most commonly feed on fungi.
4. During late summer and early autumn when food is plentiful most of the fungi are eaten by squirrels, but in late autumn and winter rabbits feed on them as well.
5. Only in the case of the buried fruits of the false truffle (*Elaphomyces granulatus*) do rodents appear to assist materially the fungus in the distribution of the spores.

TRAINING IN PLANT PATHOLOGY.

By J. Ramsbottom, M.A., F.L.S.

In the present communication I wish to suggest certain points which call for attention in considering the future of economic mycology in this country; and many of the points refer equally well to economic zoology. Owing to lack of time for preparing this note I am unable to refer to special points which arise from a study of the questions as treated abroad; but during the past few years I have had opportunites of talking over such matters with some of the leading mycologists of other countries.

As a nation it must be admitted that we rank very low in the scale where plant pathology is concerned. There are not half a dozen plant pathologists in this country who have any reputation abroad; and the number of first class men in our colonies is just as few. It cannot be denied that this is almost entirely due to lack of proper training. In America phytopathologists are often given the popular name of "plant doctors," and it would be all to the good if we would realise that plant "doctors" require training as such just as do any other doctors. The training in general botany which a

student usually receives leaves little to be desired except on the systematic side—but, fortunately, plants of economic importance can hardly be misidentified. In this country, as a general rule, after a student has had training in botany, pure and simple, he is appointed to a pathological post without further studies. Sometimes a short course of lectures is given on plant diseases but this can teach very little: and the ordinary subjects in a university botanical course are often far too specialized towards the end of the period of study to be of more than theoretical interest. A plant pathologist must know his general botany but what seems to be usually forgotten is that he should also have a knowledge of the general principles and practices of agriculture and horticulture, if not also of forestry, of soils and their properties and of manures and their effects. On slight consideration the necessity of this knowledge is obvious; there is more in the subject than a general exhortation to either spray or burn. How a student is to attain such knowledge is a question for the Universities. The information to be attained is very extended and a special training is necessary—but the investigation of disease in any group of organisms is a highly complicated study. Why not a diploma in economic mycology (and one in economic zoology), the course to extend over four or five years?

There is still left for consideration the important question of the identification of the causal organisms of a disease, entomological, bacterial, fungal &c. The study of fungi in the schools is almost entirely devoted to what is simply cytology and useless from a pathological point of view. If I were to state the simple truth regarding some of the "identifications" I have been asked to confirm for men engaged in combating plant diseases I should be judged guilty of exaggeration. It seems strange that one should have to insist that plant pathologists should be able to identify in all their different life stages the fungi with which they are concerned; also that it is not sufficient for inspectors to rely on "hand and eye" characters for the identification of micro-organisms. To advise a farmer to burn his stock when it is absolutely unnecessary is not economic botany. Naturally a general plant pathologist cannot be expected to do without the assistance of an expert systematist in certain cases: but although the work of the two overlap to some extent the ordinary run of species is certainly within the range of the former.

In the case of men who receive government appointments the final year's study might very well be taken at a central pathological laboratory and experimental station—we ought

also to have one or more such stations in the tropics. To this laboratory the leading economic botanists of the country should be appointed: it is not an economical arrangement to appoint men who, for all practical purposes, have to learn their subject after appointment. Every branch of the subject should be treated at this institution from its practical side. The students in training would have special facilities in the way of specimens, literature, apparatus &c., and the most recent methods of attacking economic problems could be studied. Scholarships could be held for the working out of special problems—but the institution should be essentially concerned with research and research methods and not with ordinary teaching. Those in charge of the station should be given opportunity for studying the condition of plant pathology in other countries and in this way would be fitted to take their share in the international attempts which are certain to be made sooner or later to eradicate plant diseases. To this central station the government inspectors could go for at least half their time to carry out experiments and have an opportunity of putting their ideas to the test.

From this station would go out the advice to farmers in the form of simple directions and explanations while the full discussions of results could be published in the form of bulletins. Men with colonial appointments could study general methods here and obtain their knowledge of indentification and of literature: but there is need for one or more central stations for the study of tropical diseases which must be investigated in the countries where they occur and with a knowledge of special conditions. It would be at these stations that the work from certain of the colonies could be best co-ordinated and not in this country where there can be no real knowledge of the special conditions obtaining.

A policy of tinkering here and there will not satisfy the obvious need and is the least economical in the long run as the break from our present method of dealing with these matters must come sooner or later.

There are endless problems which face the mycologist at present, and it is lack of opportunity, lack of capital (apparatus &c.), lack of labour &c. that hold back the few men who have successfully surmounted the primary difficulties brought about by lack of proper training.

If we are to cultivate the land at home intensively, make the most of our colonial possessions and take our fair share of the burden of investigating the international problems connected with plant disease it is necessary for us to put our mycological house in order.

PRESIDENTIAL ADDRESS.

By E. W. Swanton.

EDUCATION IN MYCOLOGY.

We may suppose that Man's education in mycology began in very remote prehistoric times with experimental tasting of certain kinds of fungi, and there is no evidence that his education made any further progress in Egyptian times.

In the 5th century (B.C.) the Greek writers Euripides and Hippocrates recorded cases of accidental poisoning through eating fungi, and about two hundred years later another Greek, Theophrastus, indulged in some philosophic musings on the nature of fungi.

The oldest extant illustration of a fungus was made by a mural painter at Pompeii in the first Christian century: divested of the volcanic ash which concealed and preserved it for nineteen hundred years it has been identified with *Lactarius deliciosus*.

Though the views held at that time concerning the origin and development of fungi were very wide of the mark, yet there is evidence that the economic study of these plants was increasing. It had been ascertained that crops were liable to attack by Rust, and a spring festival, the Rubigalia, or Robigalia, was instituted with the object of propitiating the god Robigus who alone was supposed able to avert the attack. It was known that some of the larger fungi possessed medicinal properties, but the curative values were greatly over-estimated. With increased knowledge of poisonous kinds, rules and tests for distinguishing between edible and injurious species were drawn up, and remedies were devised for the ill effects of the latter; attempts were also made to neutralise the poison of fungi by employing special methods of preparing them for the table. The cultivation of edible kinds was not neglected, but we have no evidence that *Psaliota campestris* was grown from spawn. Dried fungi were used as tinder. Such in brief, was the knowledge of fungi in Roman times,*

* See Professor Reginald Buller's Address on "The Fungus Lore of the Greeks and Romans," p. 21 of the present volume.

and during a very long period subsequently no great advance was made.

The history of the progress of investigation in various groups of fungi has been recently outlined in our Transactions. Miss Lorrain Smith in a paper on the Micro-fungi† has indicated the results of the investigations of many "inquisitive persons" from ingenious Robert Hooke to Dr. C. B. Plowright in whom the bump of inquisitiveness was remarkably developed.

Miss Lister has given a delightful account of the Past Students of the Mycetozoa and their work.‡ In a quotation from the 16th century German herbalist Hieronymus Bock she shows that mycology had not made much, if any progress during a period of fifteen centuries. Pliny believed that Truffles "are a kind of earthly concretion," whilst Bock thought that mushrooms are merely "the superfluous moisture of the earth and trees, of wood and other rotten things."

Mr. J. Ramsbottom in a series of three papers dealing with the history of the classification of the Uredinales,* Discomycetes§ and the Phycomycetes‖ has provided some valuable notes on the work accomplished by mycologists since the dawn of the 16th century. He observes that "at the time of the Renaissance the whole aim of botanists seems to have been to obtain clearness as to the identity of the plants mentioned by classical writers;" and that from a historical point of view interest centres to a surprising extent "in the work of a certain few botanists no matter which group of fungi is in question." We must not forget that the work of the 16th century mycologists was done without the aid of the compound microscope. Though the magnifying property of the simple lens was known to the ancients, yet it was not until 1590 that the first compound microscope made its appearance. Zacharias Jansen, a Dutchman, is credited with the invention. It was a feeble instrument, and for a long time was accounted nothing more than a curious toy; but that its possibilities were quickly realised by English botanists is evident from the fact that some fifty years later, in 1665, appeared Robert Hooke's famous work "Micrographia or some physiological descriptions of minute bodies made by magnifying glasses with observations and inquiries thereupon." That classic volume contains the earliest known study of microscopic moulds.

† Trans. Brit. Mycol. Soc., III., p. 18.
‡ Trans. Brit. Mycol. Soc., IV., p. 44.
* Trans. Brit. Mycol. Soc., IV., p.77.
§ Ibid, p. 382.
‖ Ibid, p. 324.

The discovery of the achromatic lens by Christopher Hall in 1729, awakened the deeper spirit of scientific enquiry which has been maintained increasingly until the present time. The possessors of that spirit are a very small minority, and in all branches of science strenuous effort on the part of those possessed of a natural gift for popular teaching is required to fan and keep alight the flame of public interest in scientific matters. Especially so is it with Mycology, which being concerned with a division of the vegetable kingdom comprising plants that are still largely regarded as uncanny, but slowly attracts adherents.

Interest in the flowering plants has always been more easily fostered, and, apart from aesthetic considerations, was largely kept going in the 17th and 18th centuries by the herbalists. Not until the close of the 18th century did it become customary to include classified descriptions of fungi in text books dealing with the British Flora. The greatest populariser of mycology at that time was James Sowerby, the author of English Botany (1797-1809) a work which included coloured illustrations of fungi. Sowerby must have been a born teacher, for he prepared more than 200 models of edible and poisonous fungi which he arranged in his house, and invited the public to inspect, free of cost, two days in each month. In 1844 the models were acquired by the nation, and, in a restored condition, may be seen in the Department of Botany at the British Museum.

During the first half of the 19th century the energies of mycologists were largely devoted to the description and classification of new species. Then, as now, the man in the street had no interest in dry-as-dust terminologies, exact though they may have been, and mycology made but slow progress. Later, when Darwin's mighty genius had expanded the entire outlook of the world of science, botanists realised that the primary object of investigation is the living plant, not the dried herbarium specimen; and the students of plant life are now ranged in two main groups, in one are those engaged in investigating cell and tissue, in the other the workers are striving to ascertain the evolutionary history of the plant and the influence of environment upon it.

Research work in all departments of botany yields results of national importance, perhaps such are more marked amongst Fungi because of the widespread damage that parasitic species may cause to cultivated plants. The value of the work which is being carried out by mycological researchers will be best appreciated by giving some data concerning the losses through fungus pests that have been recorded during recent years.

Prussia lost in 1891, through an epidemic of grain rust, wheat, oats and barley to the value of £20,648,147. The loss through the same cause to the wheat harvest of Australia in the years 1890-91 has been estimated at £2,500,000, a trifling sum compared with the £40,000,000 estimate of the sum total of injury caused by fungi in the United States during 1897, as given in the Year Book of the United States Department of Agriculture. Considered from the financial standpoint, the damage caused by fungus pests is exceeded only by that of war.

Some interesting statistics have apeared in the publications of the Department of Agriculture, Victoria. Writing of the Peach-leaf Curl *(Exoascus deformans)* McAlpine remarks upon the difficulty of estimating the annual loss caused by this disease. "It is greater than growers think, because a great deal of the injury really due to it is attributed to other causes. In the United States it has been estimated from reliable data that the entire annual loss is not less than £600,000."* In a chapter on the present position of the Rust in wheat question in Australia, the same authority informs us that "in a particularly bad season like that of 1889, the loss was estimated to be for the whole of Australia between £2,000,000 and £3,000,000."† McAlpine computes that 50 per cent of the potato crop of Victoria was destroyed by blight *Phytophthora infestans*) during 1910-11, and by way of emphasizing the ravages of this pest he points out that "in the United States it is reckoned that there is an annual loss from the disease of £7,500,000, and in New Zealand, for 1905, it was estimated at nearly £200,000.‡

A table has been published§ which gives the approximate losses through Smut to the wheat and oat crops of Victoria and certain American States.

* Fungus Diseases of Stone Fruit Trees of Australia, p. 16.

† The Rusts of Australia, p. 64.

‡ Potato Diseases in Australia, p. 2.

§ McAlpine, The Smuts of Australia, p. 136.

Crop.	Disease.	State.	Period.	Estimated Loss.	Authority.
Wheat	Stinking Smut (*Tilletia levis & T. Tritici*)	Victoria	1898	£ 50,000	Mc. Alpine
,,	,,	Ohio	Annual	52,083	Selby
Oats	Smut (*Ustilago Avenae*)	Kansas	1888	287,985	Kellerman and Swingle
,,	,,	,,	1889	177,199	Kellerman and Swingle
,,	,,	,,	1890	189,854	Kellerman and Swingle
,,	,,	Indiana	1889	166,151	Arthur
,,	,,	,,	1890	126,115	Arthur
,,	,,	Michigan	1891	166,666	Harwood
,,	,,	,,	1892	208,333	Harwood
,,	,,	Wisconsin	1901-3	2,812,500	Moore
,,	,,	United States	1880-1890	33,845,210	Swingle
,,	,,	,, ,,	Annual	3,384,521	Swingle

McAlpine remarks of the Stinking Smut that in more recent years the general treatment of the seed wheat has reduced considerably in Victoria this preventable loss.

The approximate estimates that I have quoted concern the United States, Australasia and Prussia, but similar damage on a greater or lesser scale is inflicted annually in all other countries. If we give but a few minutes' reflection to the mischief that is wrought yearly in every cottage garden, we realise that Massee* is not taking an exaggerated view in supposing that the annual loss throughout the world exceeds £150,000,000, and that probably double this amount would be nearer the truth. Every year the cottager sees his potatoes attacked by *Phytophthora infestans;* his apple trees weakened by *Nectria ditissima* and their fruit destroyed by *Gloeosporium fructigenum*: also he frequently experiences the disappointment of seeing his roses powered by *Sphaerotheca pannosa,* and his Hollyhocks rendered unsightly by *Puccinia Malvacearum.* To an equal extent the farmer and the forester have always before them disagreeable evidences of the silent work of destruction which is being carried out by fungus foes. Not a garden, farm or forest is entirely immune, the gravity of the losses has aroused wide-spread attention, and steps are now being taken in all countries to promote education in mycology, and to acquaint gardeners, farmers and foresters with the best methods of combating fungus pests.

* Text Book of Fungi (1906), p. 218.

I have obtained from certain countries particulars as to the educational methods therein employed. First of all let us note those of our Dominions.

Australia.

High Schools and Colleges are established in all the Australian States, and the diseases of plants are carefully studied. The importation of pests is checked to a very great extent by a Quarantine Act, and by a rigid system of inspection carried out under the Vegetation Diseases Act. To the operations of the former Act Australia probably owes its immunity from the numerous varieties of "Scab" disease of Potato.

There are departments of Agriculture in the various States. That at Victoria has issued monographs dealing with fungi that attack Citrus Trees, Stone Fruit Trees, Potatoes and Cereals. All were prepared by Professor D. McAlpine, Government Vegetable Pathologist, and are profusely illustrated. The illustrations include a large number of photomicrographs. These volumes indicate very clearly the rapid advance, during recent years, of our knowledge of fungus organisms.

In the preface to the volume concerned with the diseases of Citrus Trees* McAlpine points out that up to 1898 there were not more than four species of fungi which had been scientifically determined as occuring on orange and lemon trees in Australia, in his report issued in the following year he recorded eighty two species along with their technical descriptions; of the seventy eight additions no less than fifty one were new to science.

In the monograph which deals with the diseases of Stone Fruit Trees he describes one hundred and fifteen species, about one half of them being new. This treatise contains ten coloured plates and three hundred and twenty seven other illustrations.

The volume on the Rusts of Australia contains full descriptions of one hundred and sixty one species, a notable advance on M. C. Cooke's Handbook of Australian Fungi published fourteen years previously, which enumerated seventy two species.

The monograph of the Smuts contains fifty six plates, of which thirty are reproductions of photomicrographs.

In the preface McAlpine replies to the criticism that his volume on the Rusts contains far too many photomicrographs. "The unquestioned fidelity to nature which photo-

*Fungus Diseases of Citrus Trees in Australia, p. 7.

micrographs represent, far outweighs the seeming clearness and explicitness of an ordinary drawing. It is really astonishing how often scientific error is perpetuated, because it is based on drawings of what the author imagined but did not really see."*

The volume which is concerned with Potato diseases contains fifty plates, chiefly from photographs. Plate XVII has special educational value in that it shews side by side the produce of treated and untreated seed potatoes. Such illustrations capture the imagination of growers, and convince them that they will be well repaid by acquiring some elementary knowledge of botanical science.

South Africa.

I am under obligation to Mr. I. B. Pole-Evans, M.A., B.Sc., F.L.S., Chief of the Division of Plant Pathology and Mycology, Union Department of Agriculture at Pretoria for the following particulars concerning the recognition that mycology receives in the Union of South Africa.

The Transvaal Government in 1905 appointed the first official mycologist. In 1911, under Union, the Division of Mycology and Plant Pathology was established in the Union Department of Agriculture, this Division was recently incorporated with the Division of Botany. Mycology is given considerable prominence in the Department of Agriculture. The headquarters of the Division of Botany is at Pretoria, and a Phytopathological Laboratory is established there which is probably one of the most up-to-date as regards equipment. It is also furnished with a large number of illustrations, both coloured and otherwise, of edible, poisonous and parasitic fungi. Specimens are exhibited in the museum attached to the laboratory. The public take full advantage of these educational advantages, and every year sees an increase in the number of enquirers. Under the Department of Agriculture mycology is given a place in the curriculum of the Agricultural Colleges and Schools, and the fungi which attack farm crops naturally receive the chief attention.

A station for the investigation of tropical and sub-tropical growths has recently been opened at Durban, and is administered from the laboratory at Pretoria, at the latter city there is a large mycological herbarium containing an extensive collection of South African fungi. Particular attention is being given to the rusts growing on economic and indigenous plants, and also to the mildews which occur thereon.

Mr. Pole-Evans forwarded a parcel of literature issued in

* The Smuts of Australia (Ustilagineae), p. 6.

recent years by his Department. It contains valuable papers by himself, Miss Ethel M. Doidge M.A., F.L.S., Mr. Paul A. van der Byl M.A., and by Mr. Averil M. Bottomley B.A., which indicate the vigilance of these investigators in combating fungoid and bacterial disease in South Africa. Three classes of bulletins are issued, viz.: Science, Farmers, and Technical. The great majority are illustrated in black and white from excellent photographs.

Canada.

Dr. H. T. Güssow, Dominion Botanist has kindly supplied the following memoranda respecting mycology in Canada.

The general public, particularly the agricultural and horticultural community, is afforded a unique opportunity in matters concerning economic mycology, by a visit to the various agricultural Experimental Farms and Stations established by the Dominion Government throughout Canada, where the effect of control measures against the ravages of fungus diseases is being demonstrated successfully every year.

The Department also maintains at the Central Experimental Farm, Ottawa, a scientific laboratory and technical staff, under the direction of the Dominion Botanist, largely devoted to researches in all phases of plant pathology, of which mycology is a part. This laboratory keeps in close touch with farmers by correspondence, and by personal instruction or demonstration carried on, if necessary, on the premises of farmers where economically important diseases occur. The laboratory also serves as a bureau of information on such matters, and the botanical staff is at the service of the public of Canada without any cost to any consultant.

Interest in the control of diseases is greatly encouraged in every possible way. Plant Pathological Branch Laboratories have been established in various parts of the Dominion. The officers in charge carry on educational campaigns, demonstrations on farms throughout their district, and in the winter months hold short courses on the control of plant diseases. They also carry on such experiments along these lines of work, and in as many different localities as advisable, in order to become fully acquainted with the behaviour of certain parasitic fungi, under the various climatic and geographical conditions existing in a country of some 4,000 miles latitude from the Atlantic to the Pacific. Facilities exist under which farmers or fruit growers reporting any particular troubles may be visited in the briefest time by a technical officer of the district to advise and assist in the carrying out of control measures.

The Central Laboratory issues annually a report of its work, of which some sixty thousand copies are distributed through the mailing list of the Department. From time to time bulletins, pamphlets and circulars are issued on special subjects dealing with the control of specific economic diseases. Editions, sometimes as large as one hundred and sixty thousand, are distributed free of cost to the interested public.

Coloured illustrations, particularly wall charts or folders of convenient size have been issued as necessity arose and widely distributed. These illustrate mycological pests. There is not at present a sufficient desire for information on poisonous and edible mushrooms to warrant the publication of coloured illustrations of such, but exhibitions of edible and poisonous fungi have been prepared and shewn in districts where there were particular demand for such demonstration. All literature published by the Departments of the Dominion Government is issued in the French as well as the English language.

Mycology is not taught as a separate subject in colleges and schools. The students of the various agricultural colleges naturally receive an elementary training in Plant Pathology as far as required when taking biological courses. There is no special chair of plant pathology endowed at any of the Canadian Universities. Mycological instruction is given to the students of botany, and the amount depends largely upon the tendencies of the professors. The Universities are fortunate to have such men as Buller, Faull and others who have distinguished themselves in mycological researches.

The difficulty of securing reliable statistics on the prevalence of fungus pests increases with the size of the country, and it can well be realised that an organisation of immense character would be required to enable the Dominion Government to collect such data with any degree of reliability. Such action has not as yet been taken, but determination of the losses due to certain epidemics have been made from time to time for certain districts and for certain crops. The staff of the Central Laboratories address from time to time public meetings on the subject of the economic importance of plant diseases as occasion arises. There are no Mycological Clubs in Canada.

India (Bengal).

I am informed by Mr. J. A. Blackwood that mycology has not as yet received much attention in India, though, being in charge of the Agricultural Department of Bengal solely, he does not feel in a position to state definitely what is being done in other districts.

The Bengal Agricultural Department has on its staff a Mycological Collector who works under the supervision of the Economic Botanist. Specimens of diseased crops are forwarded to him by the public from all parts of the Province for examination and advice, and whenever necessary he visits the affected tracts with his microscope to study the disease on the spot. He also attends the various Agricultural Shows and Exhibitions where he delivers lectures on the commonest fungoid diseases, exhibits specimens of diseased crops, suggests methods of prevention and treatment, and gives practical demonstration on the preparation of fungicides and the use of sprayers. A few pamphlets and leaflets, in English and Bengali, with coloured plates and descriptive letter press have been written by him, and these are distributed free on such occasions among the visitors.

Elementary botany (including mycology) does not find a place in the curriculum of any schools in Bengal. Two or three Colleges affiliated to the Calcutta University teach Botany (with mycology) up to the B.Sc. standard. There is at present no Agricultural College in the Province, the Sabour Agricultural College established by the Bengal Government some six years ago now lies in the new province of Behar and Orissa, but most of the students of this College go there from Bengal. Cryptogamic Botany is one of the subjects of study in the College, and special stress is laid upon diseases of plants. There is a two-year course in Mycology at the Agricultural Research Institute and College at Pusa. This is a post-graduate course to which eight students can be admitted every year who have passed with credit through a Provincial Agricultural College or are graduates of an Indian University.

The Pusa Institute is the chief centre of mycological work in India. It owes its inception to the generosity of Mr. Henry Phipps, who, in 1903, placed at the disposal of the Viceroy (Lord Curzon) a sum of £20,000, to which he subsequently added another £10,000, to be devoted to some object of public utility in India, preferably in the direction of scientific research. With part of the gift a Pasteur Institute was set up at Coonoor in southern India; the balance was ultimately used to establish the Pusa College and Research Institute, to which a farm of some thirteen hundred acres is now attached. The Annual Report of the Board of Scientific Advice for India contains a summary of the mycological work carried out at the College, prepared by the Imperial Mycologist, Mr. E. J. Butler M.B., F.L.S., the author of many valuable papers on economic and systematic mycology. Mr. Butler informs me that no general bulletins or pamphlets of

an educational character have been published at Pusa, but vernacular leaflets dealing with specific crop diseases have been prepared and distributed free in certain affected districts. The important "planters'crops" (tea, coffee, &c.) do not usually come within the scope of the Pusa mycological section, as the Indian Tea Association has its own mycologist (Mr. A. C. Tunstall), and the South Indian Planters' Association has a planting expert (Mr. R. Anstead) who, with some assistance from Pusa, do most of the work amongst European planters. In the Journals of these Associations, various popular articles have appeared, notably by Mr. Tunstall in the Quarterly Journal of the Indian Tea Association. There was a series, running through several numbers, dealing with the principal types of fungi, and one in the course of publication deals with the fungi affecting the roots of tea plants. A considerable number of descriptive and research papers on Mycology have been issued from Pusa and the few other centres in India where mycologists are stationed.

Excepting the few leaflets alluded to above, no mycological literature has been distributed free by the Government. The cultivators are usually insufficiently educated to understand such, and the mycologists rely chiefly on direct demonstration to get remedial measures carried out. It is pleasurable to record that some of the demonstrations have been markedly successful, for example, following one on the use of copper sulphate against Sorghum smut, the Bombay Department now issues 1-anna (penny) packets through the agency of a private firm, and expect to sell about two hundred thousand this year. The loss from this disease in Bombay Presidency alone is believed to be in excess of one million sterling annually.

Public interest in mycology is slight. Some show cases prepared at Pusa, have been sent out several times to Agricultural Industrial and other Exhibitions, but Mr. Butler does not think they have accomplished much as yet from the educational standpoint.

Bonâ fide workers in any branch of botanical science may consult the collections and library at the Royal Botanical Garden, Calcutta. There is throughout India a lack of mycological clubs to foster interest in fungi.

In passing on to allude to mycological work in the United States, France, Holland, Denmark and Norway I wish to point out that the omission of other countries—Germany, Austria, &c.,—results from abnormal conditions brought about by the World War, and not from any purposeful selection on my part. Those conditions prevented me from obtaining the direct information that I wanted.

United States.

Mr. C. H. Lane, chief specialist in Agricultural Education, informs me that courses in economic mycology are given at all the State Agricultural Colleges and many other higher institutions of learning, and that the educational effect of these courses is very great. In addition there are large extension forces which deal with the practical phases of parasitic fungi in their relation to crop production by means of lectures, publications* and demonstrations. The methods appear to be much the same as those already noted for Canada. Experiment stations and universities contribute, at irregular intervals, publications on the subject of mycology; the former emphasize chiefly the economic or pathogenic importance of the species, while the university publications are more technical, and are often monographs on a single genus.

As regards the popularisation of mycology, Mrs. Flora W. Patterson, Mycologist in charge at the Bureau of Plant Industry tells me that comparatively little effort has been made in this direction. I gather, however, from the information that she has kindly supplied, that the United States does not lag behind other countries in this matter. The interest in the subject has been local rather than general, and largely confined to persons interested from the mycophagist point of view than from the systematic or technical side of the subject. In recent years the Museums of various institutions, such as the Museum of the New York Botanical Gardens, the Brooklyn Museum of Arts and Sciences, and the Botanical Museum of Harvard University have prepared exhibits of mushrooms and certain other fungi of unusual or striking appearance, with brief descriptions and notes on their economic value, habitat, time of occurrence, &c. Though the Department of Agriculture has not now any special exhibits, it encourages amateur collectors, and identifies numerous specimens sent in by correspondents or local collectors. In addition to dried specimens that office possesses a large collection of photographs and coloured illustrations; many of them were taken in the field, and convey an idea of natural habitat and surroundings. The collection includes a number of water colours and photographs prepared under the direction of Dr. Thomas Taylor, a pioneer in mycology in the United States. In 1876 Taylor was "microscopist" of the Department of Agriculture, in that year he prepared an

* Many publications dealing with economic fungi have been issued by the Bureau of Plant Industry. They are catalogued in the Price List of United States Public Documents relating to Plants.

exhibit for the Centennial Exposition in Philadelphia, unfortunately the majority of his specimens were permitted to be destroyed. Amongst the mycological works published in the United States are several which are readily comprehensible by the amateur, they include G. F. Atkinson's "Studies of American Fungi," and M. E. Hard's "Mushrooms, Edible and otherwise."

In 1915 the United States Department of Agriculture issued a bulletin (No. 175) on "Mushrooms and other common fungi."* It includes descriptions of one hundred and fifty nine species, many of which are illustrated (in black and white from excellent photographs), keys to the genera, a glossary of scientific terms, and numerous recipes for cooking and preserving mushrooms. The authors are to be complimented on having produced a brochure of high educational value.

Perhaps the most important of American mycological periodicals is Mycologia, a publication of the New York Botanical Gardens; it superseded the Journal of Mycology and the Mycological Bulletin published by the late Dr. W. A. Kellerman. For many years Professor C. H. Peck, State Botanist of New York, has been a prolific writer on mycological topics, but his active work has ceased owing to ill-health, and his large collection is not fully arranged for exhibition.

There are in several of the large cities enthusiastic mycological clubs. Their programme consists of excursions, collections and discussions, with occasional mushroom banquets. The cities Milwaukee, Pittsburgh and Boston† have very large organisations which include members interested in the taxonomy of fungi other than edible species. Cincinnati is fortunate in numbering amongst its citizens Mr. C. G. Lloyd who has by unwonted energy and liberality done much to further the progress of mycology. He has formed in that city a large herbarium of fungi, and a magnificent library of mycological literature. He has written many valuable monographs and papers which he has freely distributed amongst field mycologists in every part of the globe. His labours—they are not confined to the propagation of a knowledge of fungi—are deeply appreciated by all mycologists, and many of us feel that the world is in need of many more philanthropists of the Curtis G. Lloyd type.

* By Flora W. Patterson, Mycologist, and Vera K. Charles, Assistant Mycologist, Office of Pathological Collections and Inspection Work.

†·The Boston Mycological Club has been a member of our Society since the year 1900.—C.R.

France.

Economic mycology receives special attention in France. The Station of Vegetable Pathology at Paris supplies free information concerning parasitic fungi, and the Inspectors of the Service of Phytopathological Inspection—in addition to their supervision duties instruct nurserymen in the knowledge and treatment of fungus diseases. At Antibes (Alpes Maritimes) and Cadillac (Gironde) the professors of Agriculture give consultations on these subjects, and some part of their lectures to farmers is devoted to vegetable pathology. Temporary organisations (Congress of Farmers and Experimental Farms) have been established at various times to teach farmers how to combat certain particularly dangerous maladies of cultivated plants, such as the Black Rot of the Vine.

A public information bureau is attached to the greater number of the Schools of Agriculture, and the agricultural press plays an important part in the diffusion of mycological knowledge. A great part of the botanical courses at the Agricultural Institute, and at the national agricultural colleges (Grignon, Montpellier and Rennes) is devoted to mycology and particularly to parasitic fungi. Parasitology also constitutes an important part in the courses concerned with the culture of plants, and especially so in connection with the Vine, for the diseases of American origin which have invaded the vineyards have given mycology supreme importance.

No general statistics are available concerning the damage caused by parasitic fungi, but the annual loss is of course very considerable. It must be remembered that the two chief fungus parasites of the Vine, *Plasmophora viticola* and *Uncinula spiralis* are each capable of bringing about the almost complete disappearance of the Vine from France.

The Office of Agricultural Information, through the direction of the Minister of Agriculture, distributes gratuitously an illustrated précis on the Diseases of Plants drawn up by Dr. Delacroix, senior Director of the Station of Vegetable Pathology. This office also publishes summaries of information supplied by the Professors of Agriculture. An abbreviated review of the collected information on the life histories of parasitic fungi is given in each volume of the Annales des Epiphytes.

Of the Societies that are specially concerned with mycology the Société mycologique de France takes the first place. This Society was founded in 1885, its headquarters are 84 rue de Grenelle, Paris. It furthers mycology by holding month-

ly meetings, by issuing a quarterly bulletin, by holding a national commission (founded in 1902) directed to group the efforts of all who are interested, by an annual excursion followed by a general meeting and a public exposition of the fungi that were found, and by short excursions in the neighbourhood of Paris during the autumn months. The Société mycologique de la Côte d'Or (Dijon, Côte d'Or), the Association mycologique Lédonienne (Lons-le-Saulnier, Jura), and the Société Lorraine de Mycologie (Nancy, Meurthe-et-Moselle) are affiliated Societies. The Société Pathologie végétale de France (63 rue de Buffon, Paris) was founded in 1914 under the Presidency of M. le Professeur Mangin, it enrols those who are interested in plant diseases generally, and publishes an illustrated bulletin.

With regard to the popularisation of mycology "they order this matter better in France" than in any other country, there is abundant literature which stands unrivalled in the artistic excellence of its illustrations. One of the best known popular publications is the journal L'Amateur de Champignons. Eight parts appear annually.* Two coloured plates by A. Bessin are issued with each part. In the happy combination of accuracy and very attractive method of presentment Bessin's plates occupy a unique position, whilst those of Emile Boudier in his great work "Içones mycologicae" are "the most artistic and thoroughly scientific illustrations that have been published."†

I am indebted to M. Moreau, secretary of the French Mycological Society, for some particulars concerning the methods of furthering public education and interest in fungi. In the majority of towns frequent excursions are arranged during the season, these are attended by fifty to two hundred people or more. A good many chemists are interested in the subject, they assist in arranging the expeditions and in demonstrating the species. In the exhibition room the specimens are displayed on plates, and the labels for poisonous species are mounted on red cards. M. Moreau remarks upon the success which attends these demonstrations "Il n'est pas exagéré de dire que l'affluence des visiteurs est telle qu'au milieu de l'après-midi on s'écrase autour des tables." He alludes to the difficulty experienced in arranging exhibitions in small towns and villages in remote situations, but notes that no place is left unvisited. Temporary demonstrations of perhaps an hour's duration are arranged by the nearest

* M. Léon Lhomme informs me that this publication ceased when war was declared, he hopes to renew it soon after the cessation of hostilities.

† Emma A. Rea, Notes on Fungus Illustrations, p. 226 of the present volume.

society to take place in the village schoolroom. If they fail to obtain the use of that or other suitable hall, the waiting room at the railway station or some convenient open spot is used for the purpose. The fungi demonstrated on such occasions are arranged on pasteboard plates resembling those used by pastry cooks, and the labels are prepared beforehand. The lecturer points out the dangerous species, denounces the questionable proceedings of countrymen who with imperfect knowledge, profess to be able to distinguish between edible and poisonous kinds, and replies to all questions that may be asked. M. Moreau remarks that the villagers always evince a lively interest in these demonstrations.

Holland.

The Director General of Agriculture at the Hague asked Professor Dr. J. Ritzema Bos to furnish me with a report on what is being done to further mycology in Holland, and I am under obligation to him for some of the following particulars.

Technical mycology (Saccharomycetes, &c.) is taught at the Technical High School in Delft, and at the Agricultural High School in Wageningen. Instruction concerning the principal plant diseases caused by fungi is provided in the secondary agricultural and horticultural schools, but mycology is, as a rule, neglected in other schools. The Inspector of State forests has published a coloured wall chart (with descriptive letterpress) depicting four of the principal fungus diseases of forest trees, viz., *Armillaria mellea, Fomes annosus, Dasyscypha Willkommii* and *Lophodermium Pinastri.* This excellent chart is widely distributed gratuitously by the Government.

The Royal Phytopathological Service, centred at Wageningen, is concerned with the inspection of nursery stock and potatoes destined for export, and with combating fungus and animal pests in the nurseries, bulb farms, orchards &c., it is also gathering statistics concerning their propagation. This service was established in 1899, in which year certain American states prohibited the importation of bushes unless such were accompanied by an official certificate that they had been inspected and found to be free of insect and fungus pests. Mindful of their growing trade with the United States in horticultural produce, the Dutch Government instituted the Phytopathological Service for the inspection of nurseries only. Later on it became necessary to inspect parcels as well as nurseries, the American prohibition having become more severe through unscrupulous nurserymen sending parcels of uncertified material by post.

At the Royal Phytopathological Institution, which is also situated at Wageningen, research work on the diseases of plants is carried out, and reports are published annually. It is the centre of the operations of the Service, and is aided by the Director-General of Agriculture and the professors at the horticultural and agricultural colleges who act on committees in the various districts.

There is a private phytopathological laboratory (Willie Commelin) at Amsterdam, where a great number of fungi are grown in pure cultures and supplied to mycologists. The chief field club is the Netherland Mycological Society. It was founded at Amsterdam in October 1908. It is forming a standard collection in the Royal Herbarium at Leiden, but its special aim is the promoting of knowledge of the larger fungi. It issued in 1911 a pamphlet dealing with the points of difference between the virulent *Amanita mappa* and *A. phalloides* and the esculent *Psaliota campestris;* and directing attention to the characteristics of the genera Volvaria and Entoloma. The well know quartette of edible species, *Clytocybe nebularis, Marasmius oreades, Laccaria laccata* and *Boletus luteus* are also described. The coloured plates which accompany this pamphlet are not very meritorious. The Society holds an annual foray and exhibition (Paddenstoelententoonstelling), and publishes a report with woodcut illustrations of the most interesting species. A resumé in French accompanies it. I note, by the way, that Miss C. Cool, the Conservator of the Royal Herbarium at Leiden, appends to her paper on pure cultures of some of the larger fungi an abstract in English. The exhibitions have met with gratifying success. At the third, which was held at Arnheim, 21st to 23rd September, 1912, about three hundred and fifty species of the larger fungi were shewn, and fifteen hundred people visited the show during the three days.

Denmark.

Professor F. Kölpin Ravn, Plant Pathologist to the Danish Government informs me that at the Royal Agricultural College there are three separate courses for students in Agriculture, Horticulture and Forestry. In each mycology is given an important place, and it also forms part of the curriculum in all the secondary agricultural or horticultural colleges, of which there are about twenty in Denmark. Leaflets, pamphlets, and bulletins concerning plant diseases, are distributed by the State Experimental Stations, and actual specimens are sent under separate cover. No coloured charts of fungi have as yet been published,

indeed judging by the pamphlets that I have seen, the educational value of good illustrations does not seem as yet to be properly appreciated in Denmark.

Statistics of losses through fungus pests are not available, but as the annual value of the total Danish harvest is five hundred to seven hundred million kroner, an average loss of only one to two per cent would amount to from five to fifteen million kroner per annum, a sum which conveys a clear idea of the great economic interests which are involved. Hence the popularisation of mycology receives strong Government support. The State Botanical Museum at Copenhagen arranges almost yearly, and usually in co-operation with the Danish Botanical Society, an exposition of fungi, a special feature of which is an exhibit of edible and poisonous species. There is also a Society for encouraging the study of fungi, akin to our Society. It was founded in October 1905; at the present time there are three hundred and fifty members. Four or five forays and from one to three exhibitions are held annually; the Transactions contain papers on general mycology, cultivation of fungi, domestic uses, &c. There are also fungus forays held in connection with various local natural history societies.

Norway.

I am informed by Mr. W. M. Schöyen, the State entomologist, that information concerning the common parasitic fungi of cultivated plants, is given in the agricultural colleges, and the schools of gardening and forestry. At the Government Agricultural College the state entomologist gives instruction on injurious insects, and also on parasitic fungi, amounting to from eighty to ninety hours annually. In other agricultural schools the teaching is less.

No statistics as to yearly losses through fungus pests are forthcoming. The State entomologist prepares an illustrated annual report on injurious insects and fungi. The illustrations, all in black and white, are reproduced in an economical manner, the ravages of insects and fungi being depicted side by side on the same plate. Dried specimens are used for teaching purposes, also coloured illustrations of German origin. There is but slight popular interest in fungi, and it is chiefly confined to a knowledge of certain edible and poisonous kinds.

Development of Mycology in Britain in Victorian and later times.

No serious attempt appears to have been made prior to the latter half of the nineteenth century to stimulate popular

interest in fungi in Great Britain. An educational crusade was initiated by the Woolhope Club, a few years after its establishment in 1853. This famous Club commenced in 1868 to hold autumnal forays, a plan which proved so attractive that it was quickly adopted by naturalists' clubs in various districts. It also held public exhibitions of fungi, and by means of fungus suppers, attempted to demonstrate that much good food was wasted every autumn through sheer ignorance, but whether many deaths resulted from ignorant persons following the example set by Dr. Bull and other zealous mycophagists I know not. Within a few years of the formation of the Club there was a noticeable increase in the out-put of illustrated mycological works, a sure indication of its stimulating influence. Berkeley's Outlines of British Fungi appeared in 1860, and Sarah Price's Illustrations of the Fungi of our Fields and Woods were issued in 1864 and 1865. Two large plates, by Worthington G. Smith, of edible and poisonous fungi appeared in 1867. The letter-press which accompanied them contained an amusing instance of the indiscretions which even veteran fungus-eaters may commit. The author essayed the difficult task of gathering Champignons in the dark, and sent his gathering to the cook without troubling to give it ocular inspection. Half an hour after eating the fungi he experienced violent symptoms of poisoning, which, luckily for him, were followed by vomiting. He made a fairly rapid recovery and attributed his illness to *Marasmius urens*.

Fungus exhibitions were held annually at the Royal Horticultural gardens in the sixties and seventies, and apparently were very popular. One which took place on October 14th, 1871 was reported to have been more successful than any of its predecessors, " nearly all the British edible and poisonous fungi were shewn in a living state, including several rare species,"* and the visitors evinced the greatest possible interest in them. In 1874 three prizes of £3, £2 and £1 were offered in each of four open classes at the exhibition. That year saw the first Scottish exhibition. " Almost every county in Scotland made large contributions, and almost every fungologist in Britain contributed specimens."† The exhibits numbered about seven thousand, easily beating all previous British records. Writing in 1886 Dr. M. C. Cooke remarked that the recorded number of British species had been nearly doubled in fifteen years. No doubt the exhibitions had materially contributed towards that excellent attainment.

* Nature, Oct. 12th, 1871
† Nature, Sept. 11th, 1874.

The rapid increase in field workers during the next decade led to the establishment of the British Mycological Society in 1896. Under Mr. Carleton Rea's inspiring guidance the Society quickly became a powerful factor in furthering education in mycology. Within ten years of its foundation it received an invitation, from the Corresponding Societies Committee of the British Association for the Advancement of Science, to apply for enrolment on the list of the Affiliated Societies of the Association; and our Secretary was informed on the 6th March, 1906, that the British Mycological Society had been placed on the list "in consideration of its local scientific work of an original character." In the following year Mr. Rea read on behalf of the Society, at the Conference of Delegates of Corresponding Societies attending the Leicester meeting of the British Association, a paper entitled "A Plea that Local Societies should give greater attention to the investigation of the Fungi occurring in their districts, with suggestions for the encouragement of the study of this group." In that paper he commented upon the inexplicable neglect of the study of a group of plants which are of such immense economic importance, and urged the establishment of continuous exhibitions in the Club Rooms or the Museums of Natural History Societies, at which prizes might be offered for the most varied or most correctly named series of specimens sent in during the course of the year. He also advocated the drawing up of local lists, and the reading of short papers to members and to the general public.

In 1911, Mr. Harold Wager F.R.S., then President of our Society, read a paper at the Conference of Delegates, at the Portsmouth meeting of the British Association, on "The Study of Fungi by local Natural History Societies," in which he advocated increased field observation, and emphasized the value of exhibitions of edible and poisonous kinds. Our members who attended the meeting and took part in the discussion which followed, reported (at Taunton in the following autumn) that a general wish was expressed that guidance be given by the British Mycological Society to local Natural History Societies in their study of the fungi occurring in their districts. A committee was formed which drew up and sent out a circular to the secretaries of over one hundred natural history societies, wherein information was requested concerning the "Silver-leaf" disease and injuries caused by various polypores. The secretaries were also asked to supply particulars of the mycological literature published by their societies. The circular probably accomplished more than appears on the surface, for though our delegate at the Dundee meeting of the British Association, subsequently re-

ported that no adequate response had been received, it must have served a most educational purpose, in directing general attention to the study of fungi, and in emphasizing its great importance to foresters and gardeners.

The Rev. W. L. W. Eyre in his Presidential Address to our members alluded to the necessity of devising methods calculated to popularize the results of mycological investigations, and to attract to our ranks those "who are only deterred from co-operating because we are reported to be *too scientific.*"* One method might be to publish a brochure, giving a concise and readable account of fungi in general, with special reference to their influences for evil. Something of the kind has been done for South Africa by Mr. Paul A. van der Byl.† Such a pamphlet would have great educational value, and if distributed to museums and field clubs throughout the country, would also serve as a dignified advertisement. The French Mycological Society, I may note, is not above advertisement, and has reproduced on post-cards many of Bessin's plates as given in Paul Dumée's well known Pocket Atlas;‡ a short explanation accompanies each illustration, and a paragraph concerning the Society appears on the front of the card.

The value of accurate coloured drawings for teaching purposes, has been well demonstrated on the few occasions, when we have had the good fortune to see Mrs. Rea's magnificent series of paintings, set out in our exhibition rooms, but I fear that the majority of us are inclined to neglect our sketch books. Dr. Plowright in speaking of the Woolhope Club meetings that took place in the later half of the sixties, remarked that the members, whether skilful draughtsmen or unskilful, would as soon have thought of going to Hereford without their paint boxes, as of going without their hats. "The point I wish to emphasize is this: that however rude a sketch may be, it has a definite value; and I would impress upon all those who attempt the study of the Hymenomycetes, that they should make coloured outlines of any species that may be new to them. The trouble is not great, but the value, as these sketches accumulate, considerable."§

There is a very large collection of sketches of fungi at the

* "Mycology as an Instrument of Recreation," Trans. Brit. Mycol. Soc., II, 49.

† "The Nature of Fungi with reference to the Life-histories of some important Parasites." Reprinted from the "Agricultural Journal of the Union of South Africa," December, 1913, by the Union of South Africa Department of Agriculture, 1914.

‡ Nouvel Atlas de Poche des Champignons, 2 vols., Paris, 1905 and 1911.

§ "Notes and Comments on the Agaricini of Great Britain," Trans. Brit. Mycol. Soc., I., 37.

British Museum of Natural History. The exhibited series in the Botanical Gallery includes two large sheets of coloured drawings of some edible and poisonous kinds. Presumably the authorities intend to publish them with descriptions in the near future, for such a publication would be welcomed by the numerous public who are interested in fungi chiefly from the gastronomic standpoint.

A series of Worthington G. Smith's illustrations of Field and Cultivated Mushrooms and Poisonous or Worthless Fungi often mistaken for Mushrooms, have been reproduced with descriptive notes as one of the official Guide Books. May I suggest the desirability of pointing out in the next edition of this Guide, that with the delights of mushroom eating are associated the risk of incurring dyspepsia of an aggravated kind? There are many who cannot eat *Psaliota campestris* without experiencing disagreeable results. The idiosyncrasy may manifest itself at any period of life and under varying conditions of health. If the symptoms are at first slight the victim almost invariably attributes them to any cause other than fungus eating, and does not discover the true explanation until a second or even third attack has been experienced.

Attention might also be directed to Dumée's statement that *Psaliota xanthoderma*—a species often confused with *P. campestris*—is not easily digested; "il serait prudent d'être très réservé dans l'emploi de ce champignon, qui serait peu agréable au goût et d'une digestion difficile."*

The Botanical Gallery at the British Museum contains—in addition to Sowerby's models of British fungi to which allusion has already been made—Worthington G. Smith's coloured drawings of British Basidiomycetes, and Miss Lister's unrivalled series of those of the Mycetozoa.

Valuable educational exhibits of forest fungi may be consulted at Kew. The mycological work which is being done at the British Museum, at Kew, and at the Agricultural Colleges is of great national importance, but it is not sufficiently realised by the public, and will not be until instruction in elementary economic botany be given, by science teachers, in the elementary and other schools. The late Sir Jonathan Hutchinson suggested, in a letter to the Times,† that valuable instruction in economic zoology and botany, might be given in rural districts through the agency of the numerous small museums, that are in a languishing condition through lack of funds. He thought that if the Board of Agriculture subsidized them, on the understanding that they actively en-

* Nouvel Atlas de Poche des Champignons, I., 41.
† September 11th, 1911.

gaged in teaching Plant Pathology and Mycology, Agricultural Zoology and kindred subjects, such museums "would speedily become centres of active life in reference to agricultural knowledge," and if developed throughout the country, they " would become influential beyond calculation upon the general standard of attainment."

The suggestion was not taken up. The true functions of museums are still very imperfectly understood. The great majority of people look upon a museum, as a place either to be avoided altogether, or visited once in a way on a wet day. This erroneous conception will vanish, when museums are more freely used in the way that Hutchinson suggested. I have had abundant evidence, every year since 1897, of the great interest that a fungus exhibition may create in a small town. Undoubtedly the most popular of all our annual temporary exhibitions at the Haslemere Educational Museum is the fungus show. It is a perennial source of delight to our villagers and its reputation is steadily spreading in the district. Specimens of *Sparassis laminosa* and other uncommon species are frequently brought in from outlying villages. *Amanita muscaria* is often received with an apology—" I know it is common, but this one is so beautiful that I felt I must bring it along "—which recalls Emerson's assertion that " all men are poets at heart, they serve Nature for bread, but her loveliness overcomes them sometimes."

With woods and meadows almost within a stone's throw of its doors the Museum at Haslemere is in a position to maintain a fungus exhibition with the minimum amount of trouble, but Mr. and Mrs. Rea have demonstrated at Worcester, that in towns far less favourably situated a valuable exhibition may be maintained during the autumn months. The need of such, as popular educators in mycology, is very great. There are thousands who do not know what we mean when we speak of mycology ! I have been asked over and over again to explain the term " mycological."

In June a lady visitor to the Haslemere Museum told me she had heard that I was president of a learned Society, and added " I think it is called the Mythological Society." I gravely assured her that the Society she was thinking of is concerned with facts rather than fables. After I had explained its aims and objects she said " I quite understand now, you are president of the Mushroom Society," but my unuttered thought was that she was incorrect in applying that term to a Society which is about to attain its majority !

We had pleasing evidence last autumn at Swansea, that residents in districts visited by us are wishful to avail themselves of the special help we can give in mycological

matters. Shortly before the meeting our Secretary was approached to give particulars as to the best method of preventing the spread of "Dry Rot."* He read a short paper on the subject and it was published in the local press. It is expedient to develop the purely educational side of the Society's work. This might be promoted by making a county town our headquarters for the autumn foray, say every third year, and by arranging to give popular demonstrations. A lecture well illustrated by lantern slides might be given one evening. The exhibition should contain some special features, such as coloured illustrations of fungi, popular labels, educational photographs, and sections of diseased timber and fruit trees. It is to be feared that many visitors to our exhibitions have gone away convinced that we "spend our wit to name what most employ unnamed." There would probably be no difficulty in securing free of charge from the local Committee of Education a room suitable for the exhibition, and also a hall for the evening lecture. It would be necessary for one member to be in attendance every afternoon at the exhibition to act as guide and teacher, and to submit patiently and tactfully to cross examination by press representatives. The delegate for that honourable post could be chosen by lot every morning.

I note that four only of our twenty autumn forays have been held at county towns in England (Exeter, Hereford, Newcastle and Taunton), and three of the eight spring ones have taken place at Worcester, Shrewsbury and Chester, so there is a wide choice of towns.

The reference to county towns recalls an important work yet to be undertaken by the Society, viz., a census of British Fungi. There are at present but seven English counties where our Society is without a representative, viz., Rutland, Westmorland, Cumberland, Northamptonshire, Leicestershire, Hertfordshire and Huntingdonshire. There should be no difficulty in securing that representation, and we could then begin to investigate the comital distribution of the Basidiomycetes. It would be necessary to appoint a Recorder, also referees for each county and vice-county. The absence of an authoritative check list need not deter us from starting the work. It is an open secret that Mr. Carleton Rea is at work upon the much desired concise text book of British Basidiomycetes, and not until it appears will the time be

* The necessity of research work in fungi which cause injuries to timber has been emphasized by Professor Percy Groom, in his recent paper on "Dry Rot," which appeared in the August issue of the Journal of the Board of Agriculture. He estimates that the annual loss in the United Kingdom alone through fungi causing "dry rot" amounts to millions of pounds sterling.

ripe for the publication by our Society of a "London Catalogue" of British Fungi. But in the mean time the excellent manuscript list of species observed at our Forays which has been drawn up by Mr. A. A. Pearson could be extended and used by the Recorder; some copies of the list have, through the kindness of Mr. Pearson, already been made.

The need of more research workers in Mycology is very apparent. The advance of civilisation sees an annual increase in the species of plants which Man deems useful in some way or the other. These are gradually weakened by the artificial conditions to which they are immediately subjected in our desire to get quickly a superabundant yield, and thus easily fall victims to attack by parasitic fungi. Then the plant doctor is called in to find a cure. There are two parasites of the Vine which afford striking examples of the remarkable rapidity with which fungus pests may spread among cultivated plants. The powdery mildew of the grape (*Oidium Tuckeri*) first noticed in Europe about 1845 (in which year it appeared in England) reached every vineyard in the Continent within the next six years. The downy mildew of the grape (*Plasmophora viticola*) made its first appearance in Europe in 1870, within ten years it succeeded in reaching all the Continental grape growing countries. In 1895 the latter parasite caused a loss of about twelve million hectolitres of wine in Hungary alone, and at the present time the annual loss to the world's grape crop by these two parasites is considered to amount to two thousand five hundred million. The enormous losses caused annually to cereals through Rust and Smut have already received our attention. Proportionately great losses occur annually to the Potato, Apple and other crops, and it is the obvious duty of all Governments, to provide sufficient plant pathologists, to cope quickly and effectively with any epidemics which may arise, to publish the results of research work, and to make known as widely as possible the precautionary measures that the public should take. In these matters our home Government might emulate the vigorous educational measures employed in our Dominions.

We have noted that the Victoria Department of Agriculture has published and distributed in Australia, elaborate monographs of the Rusts, the Smuts and the Potato diseases of that Continent. They were prepared by the Government Vegetable Pathologist. In this country the publication of such treatises has hitherto been left to private enterprise.

Our Board of Agriculture has issued a series of coloured illustrations of fungi injurious to fruit and forest trees, and

another which portrays edible and poisonous fungi, but the price places them beyond the reach of the majority for whom presumably they were prepared. From an artistic point of view they are inferior to similiar publications which have appeared in other countries, as may be seen by comparing the figures of *Armillaria mellea* and *Fomes annosus* with those published by the Dutch Government, which, I may add, are widely distributed in Holland.

The useful mycological notes which appear from time to time in the Journal of the Board of Agriculture, are reproduced in leaflet form with an italicised footnote, which informs the public that they may be obtained post free on application to the Secretary of the Board of Agriculture and Fisheries. But a system of distribution which depends largely for its success upon the publicity gained through the subscribers to a Journal, has obvious defects. Personally I much prefer the Canadian plan of posting them to every village in the land. The Farmers' Circulars prepared by Dr. Güssow under the direction of the Minister of Agriculture at Ottawa, are distributed throughout the length and breadth of Canada. I have had many opportunities lately at the Haslemere Museum, of conversing with farmers who have thrown up their occupations—all honour to them—purposely to come over and help the Mother country in her time of need, and I gather from them that no expense is spared in their country in the production and distribution of mycological literature. In Canada they do not wait for a dangerous pest to arrive and make itself unpleasantly evident before they begin writing about it, but if there be a possibility that such may come, a warning circular is sent out broadcast, which contains a most excellent coloured illustration and references to a Bulletin in which detailed particulars may be read. One stalwart young warrior told me that Circular No.3 (a warning one which concerns the Potato Canker) is displayed in post offices in remote districts as well as provincial towns, and he was proud to mention a certain village with a population of thirty two which had not been forgotten by the Government. The Circulars have a very attractive appearance; clear type and realistic illustrations are used with good paper or cardboard, and points of special importance are emphasized by printing them in red.

The war has made us deeply conscious of dangers which arise in times of strife through neglect of Forestry and Agriculture, and there is good reason to hope that the past niggardly attitude of the Government towards these vital industries will undergo a change at an early date. The importance of mycology will then be more fully recognised,

the present system of training plant doctors will be improved, and our methods of disseminating the knowledge gained by mycological research will doubtless be greatly extended. The near future may see our post offices, public halls, museums and schools placarded with facts relating to economic zoology and botany, that it is most desirable in the national interests to impart. The fact that there are in this country to-day landowners who will not allow mycologists to explore their estates because prowling botanists may disturb their pheasants, reveals very clearly the desirability of teaching at least the elements of mycology in all schools.

Though Government intervention in these matters is urgently needed, yet public enlightenment may be largely effected by mycologists themselves. Whilst deriving great joy from adding to our stores of special knowledge, let us keep ever before us the words of the great American philosopher Emerson, "The office of the scholar is to cheer, to raise, and to guide men, by shewing them facts amidst appearances. He plies the slow, unhonoured, and unpaid task of observation—he is to find consolation in exercising the highest functions of human nature."

ECONOMIC AND FOLK LORE NOTES.

By. E. W. Swanton.

Much has been written respecting the economic uses of fungi, and the folk lore of these plants has also received attention, but it is probable that much curious information, hitherto unrecorded, may get be gleamed in rural districts, and the following notes may possibly stimulate enquiry.

Daldinia concentrica was carried until quite recently by old men in the "fold" district of West Surrey and Sussex as a safeguard against cramp. At Haslemere the little spherical tumours so frequently seen on beech and oak trunks were carried instead, and considered equally efficacious. Specimens of these "cramp-balls" as they were called, given me by old villagers, have been placed in the Haslemere Museum.

Calvatia gigantea, C. caelata, Lycoperdon gemmatum, and apparently any other species of puffball, though the larger kinds were always given preference, were at one time commonly kept in the farmhouses and cottages of West Sussex for use as styptics. The custom still lingers but is rapidly dying out. The fumes from burning *Calvatia gigantea* were used for driving bees from their hives, and at the present time bee keepers in the Godalming district occasionally employ smouldering *Polyporus betulinus* and *Daedalea quercina* for that purpose.

Fomes pomaceus has a reputation about Lurgershall and other West Sussex villages as a poultice for a swollen face. It is ground down on a nutmeg grater and heated in the oven before application.

Polyporus betulinus is still used for various economic purposes by cottagers in the villages near Godalming. In the days of flint and steel it held a very important place in household economy, because of the persistent way in which it slowly smoulders if placed in a tin with restricted ventilation. It was so kept and used for renewing or duplicating fires, thus saving the bother of making fresh ignition by flint, steel and tinder. In windy and wet weather the labourer carried a tin of smouldering amadou to the woods and fields

to enable him to make a fire to eat his lunch by. The charcoal is still valued as an antiseptic and disinfectant: it is obtained by filling a tin canister with pieces of the fungus, and placing it in a slow fire until the fumes cease to escape from the lid.

Thin rectangular strips of the flesh, about $1\frac{1}{2}$ by 1 inch, are kept as styptics, and similar strips with a circular hole about $\frac{1}{4}$ inch in diameter punched through the middle are still employed as corn pads. Strips of the size and shape of a lead pencil are used as fuses for firing the charge when blowing timber. In the raw state they are called "slow touch," those that have been steeped in saltpetre solution are known as "quick touch."

In the early part of the past century razor strops were commonly made of *Polyporus betulinus*. Mr. J. Denyer of Eashing has kindly made for the Haslemere Museum collection a replica of the strop as used in his parish. A piece of the fungus, about $6 \times 2 \times 1$ inches, is nailed to a piece of wood, the pore bearing area making the stropping surface, which was dusted with siliceous earth. Canadian soldiers who have seen this strop tell me that similar ones are made by lumber men in British Columbia, but the stropping surface is never powdered.

About thirty years ago the patriarchs in the villages of south-west Surrey and also in those of East Somerset believed that *Psaliota campestris* originated in fields where stallions were kept. This superstition was probably an echo of the curious beliefs as to the origin of fungi which were brought into this country by the Romans.

SOME OBSERVATIONS UPON THE ASSIMILATION OF FUNGI BY BADHAMIA UTRICULARIS BERK.

By W. T. Elliott, D.D.S., F.L.S., F.Z.S.

The literature that has been published regarding the plasmodia of the Mycetozoa seems very limited in detail and also very little information is given as to the substances or organisms (whether bacteria or fungi) which are assimilated or that form its food. To quote Lister (Monograph Mycetozoa, page 12), "It (*Badhamia utricularis*) is capable of being cultivated without limit on Stereum hirsutum and allied species; and can be observed under the microscope to dissolve fungus hyphae as the hyaline borders of a yellow wave of plasmodium passes over them." Again, Coulter Text Book of Botany, Vol. II., 790, says "that the food of Myxomycetes consists largely of such organisms" (bacteria). It seems to me that many of the species of plasmodia that emerge from dead wood very probably assimilate the fungus mycelium in the wood rather than bacteria; for in sections of dead wood hyphae are abundant but not bacteria, and it is possibly a greater portion of their food. In some stained preparations of this plasmodium that I had developed on Stereum hirsutum I have found nematodes and even some algae. It could readily be observed that this plasmodium was living on that fungus for it creeps entirely over the surface while it is still living and destroys it as is well known, evidently by assimilating all the less dense tissue. It was while observing this action that the idea arose to me to try the effect on various other fungi including some of the fleshy ones, and the rapidity with which it attacked and assimilated and in certain cases totally demolished some species appeared to me very remarkable. With this view I made experiments upon the following fungi:—

Stereum hirsutum	-	
Polystictus versicolor	-	Eaten but does not so readily creep off when decomposed.
Polystictus hirsutus	-	Eaten quickly.

Polyporus dryadeus -	Eaten rapidly.
Amanitopsis vaginata -	Eaten partly; the gills first.
Laccaria laccata - -	Eaten mostly.
Stropharia semiglobata	Eaten mostly.
Collybia dryophila -	Eaten mostly; the plasm becomes more dense and brighter yellow.
Marasmius oreades -	Eaten.
Amanita rubescens -	Doubtful.
Psilocybe semilanceata -	Very slightly touched.
Coprinus micaceus -	Creeps all over it, and the plasm is destroyed if it cannot get away before decomposition sets in; the colour becomes dark brown or treacly, and is more dense than the ordinary plasm.
Panus stypticus - -	Slightly touched.
Russula furcata - -	Eaten.
Russula rubra - -	Eaten slightly.
Russula emetica - -	Eaten slightly.
Boletus scaber - -	Eaten.
Boletus flavus - -	Assimilates the whole fungus; attacking the gluten and fleshy part before the tubes.
Lycoperdon gemmatum	Not touched. When cut in two it it was still avoided showing that the peridium does not act as a protection.

Controls were kept in each case where the fungus was left without any contact with plasmodium.

In the case of Boletus flavus it may be observed that it assimilated the pileus including tubes and flesh, it attacked the gluten first and the tubes afterwards but eventually assimilated the whole fungus including cellulose, sap and cell contents, the stipe excepted; the plasm becomes darker in colour, much more dense and creeps comparatively slowly; it eats holes similar to those eaten by slugs; but slugs (Limax cinereo-niger) on the other hand began by devouring the tubes first before touching any other part. To quote particulars of one experiment, a Boletus flavus three inches in diamiter was cut into two equal parts and as much plasm as would cover a threepenny piece was placed on the surface, in forty hours about two-thirds was assimilated, the half portion not subjected to the plasm remained living and did not change in appearance. Collybia dryophila twenty five hours after being treated in a similar manner showed holes similar to

those made by slugs. This experiment on Boletus flavus was also tried upon the fungus in *situ* under a bell glass in my garden and it was seen that the plasm continued to feed upon the substance of the Boletus until the fungus began to decompose after the shedding of spores; when the plasmodium died. From the observations that have so far been made one may conclude that this plasmodium will assimilate most if not all of the fleshy fungi whether poisonous or otherwise. A difference in density of the plasmodia is apparent when the fungus is fleshy, and the variation in the colour of the plasmodia is seen in the case of those feeding on fungi with dark spores; for instance, it loses its bright yellow colour and becomes darker, the colour of treacle after feeding on Coprinus. It may be observed that while the fungus is alive and shedding its spores the plasm can feed and obtain nutriment, but after decomposition has set in unless it rapidly creeps off it is destroyed, evidently not feeding on the bacteria that caused the fungus to decompose.

It is obvious that the life of these fleshy fungi is not sufficiently prolonged to allow the plasm to be developed under natural conditions, that is, from the spores developing on the fruit body; and for this reason fleshy fungi are protected from the plasmodia of such Mycetozoa on account of their short duration of life; but in the case of Stereum hirsutum which is a leathery fungus it has the opportunity to creep from the wood to the fungus and to develope for some weeks on it.

It may therefore be concluded *firstly*, that the plasmodia of *Badhamia utricularis* will entirely assimilate certain fleshy fungi, but that natural conditions and the shortness of life of such fungi are protective to them, otherwise we might expect to find them frequently attacked by this plasmodium in their natural environment.

Since writing the above I have read with much interest the experiments upon the plasmodium of this species made by Mr. Arthur Lister (Annals of Botany, Vol. II., No. 5, 1888). They are upon somewhat different lines but the results he observed were of a very similar kind; in his case the fungus tissue was cut up and given in very thin and very small slices so that the process could be observed under the microscope; whereas my experiments are made upon the whole fungus some of them growing in situ. *Secondly*, a change of colour is observed dependent to some extent upon the fungus assimilated. Lister also (l. c.) noticed the change in colour of the plasmodia and refers to "its rich chrome yellow being changed to deep brown while creeping over a Corticium on wood caused by the countless undigested brown spores of the Corticium held in suspension." This might be due to the

spores of fungi being protected from assimilation by their firm walls.

Similarly Constantineau (Annales Mycologici, 4, 1906) also observed that when *Physarum didermoides* crept over blue litmus paper and took up some of the blue particles of the paper it appeared blue instead of white and, at another time the plasm of this species changed from white to rose after absorbing bacteria having rose coloured pigment; he also noticed that the plasm of *Badhamia macrocarpa* gradually changed in colour from light to dark yellow on a solid media.

Jahn has also observed similar colour changes.

Thirdly, the density is very marked in most cases; it appears to become "fat" and thick and loses its desire to creep to any great extent. My observations appear also to confirm those made by Lister (l. c.) on A. rubescens where the plasm seemed to thrive on the hyphae but could not assimilate the whole of the spores so that in the end it became lethargic or as I have expressed it "fat." It is also indicated, as Lister has pointed out (l. c. page 14), that this plasmodium can discriminate between different foods.

In view of these experiments it is rather a moot point whether this plasmodium may be considered a parasite or not: but seeing that it feeds on living fungi, non-decomposed tissue, one feels justified in regarding it as such. These organisms are now, however, definitely placed among the Protozoa and exhibit a metabolism that can utilise proteids; and yet the literature concerning them is usually published in Botanical Journals. Being organisms on the "border line," they appear to me to be as much parasites as aphides and scale insects which creep over and suck the juices from plants, and, similarly this plasmodium crawls over these fungi, assimilates or consumes the tissue, and eventually destroys the host. They appear, therefore, to fulfil the definition of a true parasite in withdrawing nutrient substance including proteids from the host.

A NOTE ON TWO INTERESTING FUNGI: BOTRYTIS PYRAMIDALIS Sacc. AND SPHÆRONÆMA CORNUTUM Pr.

By Marie E. M. Johnson, M.Sc.

BOTRYTIS PYRAMIDALIS Sacc.* (=PHYMATOTRICHUM PYRAMIDALE Bon.†)

During an investigation upon *Panus stypticus,* in October 1915, some wood block cultures of the basidiospores produced small round white tufts, of about one to three millimetres in diameter. On examination these tufts proved to be a Hyphomycete, identified as *Botrytis pyramidalis,* which up to the present has only been recorded for Westphalia and France.

Botrytis pyramidalis appears on dead wood, as little round white tufts about 3 millimetres across. Later on, these tufts become more or less flattened in the centre, and as they often arise near to each other they become confluent, but the outline of each tiny tuft can usually be determined. When first formed the tuft is shining, but later it has a tendency to dry up a little, and to have a slight powdery appearance. Sometimes the tufts turn a deep blue green, due to a change in colour of the hyphae, conidiophores, and conidia.

The description by Saccardo is incomplete, the two following characteristics, namely, that the hyphæ are curling and that the conidiophores fall with the ripe conidia, having been omitted, although these two points were recorded by Bonorden. Also both Saccardo and Bonorden make no mention of the frequent change of colour referred to above, and they give the number of conidiophores as being from 2-5; in my specimens the number sometimes exceeded five.

Amended Specific Description.

In white or green tufts, woolly; with radiating hyphae, septate, snow white or green, dendroid, curled, with pyramidal branching; lateral branches short, with one septum giving

* Saccardo, Sylloge Fungorum, Vol. IV., p. 135.
† Bonorden, Handbuch, p. 116, Fig. 181.

off 2-5 or more swollen cells, conidiophores, which fall with the mature conidia; conidia 3-3.1μ × 1.7-1.8μ, elliptical, colourless or green, inserted in large numbers around the conidiophores.

In culture experiments the conidia germinated quite readily in rain water and other media, but the subsequent growth was always more rapid when a piece of wood was introduced into the culture.

Within twelve days a white tuft appeared on the wood, showing all the characteristics of Botrytis pyramidalis. Sometimes the whole tuft became pale green, and gradually passed into a deep bluish green colour, in other cases the whole tuft was green except the outside edge, which remained white for a short time. This change in colour does not seem to depend upon the amount of moisture present, since cultures kept in similar atmospheres with respect to moisture, sometimes remained white, while others turned green. Neither was this change in colour due to temperature, nor yet to the acidity or alkalinity of the medium, but certain observations point to light determining the change.

When cultures had been left to grow in front of a window in the laboratory, the tufts on the side of the piece of wood facing the light turned a deep green, while the tufts on the opposite side of the wood which received less light remained white. Also cultures kept in large glass vessels lined with blotting paper remained white. But the tufts on cultures kept out of doors gradually turned green, except in cases where they were produced on the under side of a horizontal piece of wood, when they always remained white.

On the other hand certain cultures bearing white tufts were removed to a dark room, while other similar cultures were placed in the lightest spot of the laboratory, the cultures being in similar atmospheres with respect to moisture; all remained white. It may be that light determines this change in colour, but unless a sufficient amount is present when the tufts first appear, they will remain white.

SPHÆRONÆMA CORNUTUM Pr.*

During the same investigation of *Panus stypticus*, I found in January, 1916, the fungus *Sphæronæma cornutum*, a member of the Sphæropsidales, which was first recorded by Preuss and Saccardo,† and up to the present has only been

* Preuss, Fungi Hoyerswerda, No. 144.
† Saccardo Sylloge Fungorum, Vol. 3, p. 195.

seen on two other occasions. It appeared on a piece of dead wood from an old log, on which were growing the sporophores of *Panus stypticus*.

The species is gregarious, and can be recognised by the black, hairy, sub-globose pycnidium, which has a long cylindrical neck of the same colour (Fig. 6), the mouth of which is fringed with a number of distinct filaments (Fig. 8), by the oval spores (Figs. 9 and 8), and by the characteristic exudation of the spores from the ostiolum (Fig. 7).

Preuss described the pycnidia as being superficial, but they seem to be partly embedded, about two-thirds of the pycnidium protruding above the wood upon which it is growing (Fig. 6).

A rather interesting point which may be mentioned here was the presence of *Haplographium olivaceum* growing along with the *Sphæronæma,* in some cases even the *Haplographium* seemed to be springing from the pycnidia. The frequent occurrence of these two fungi so closely associated suggests that there may be some connection between them.

In conclusion, I wish to thank Prof. West, Dr. J. S. Bayliss Elliott, and Mr. W. B. Grove, M.A., for help during the study of these two fungi.

EXPLANATION OF PLATE VI.

Botrytis pyramidalis.

Fig. 1.—Erect hyphæ with curling extremities, as seen when a young white tuft is examined microscopically. × 96.

,, 2.—Young lateral branch with a few conidiophores which have just commenced to bud off conidia. × 600.

,, 3.—Very young lateral branches. × 600.

,, 4.—Older lateral branch. × 600.

,, 5.—Portion of fully-developed branch with conidiophores crowded with conidia. × 600.

,, 5a.—Freshly fallen conidia seen in water. × 600.

Sphæronæma cornutum.

Fig. 6.—Pycnidium with exuded mucilaginous globule. × 80.

,, 7.—Exudation of the contents of the pycnidium. × 60.

,, 8.—Crushed pycnidium. × 60.

,, 9.—Spores in mucilage. × 600.

5a
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2.
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M. e. M. Johnson del.

STUDIES IN DISCOMYCETES. I.

By Jessie S. Bayliss Elliott, D.Sc. Birm., B.Sc. Lond.

In June, 1916, in my garden (Tanworth-in-Arden, Warwickshire) I found on the jagged end of a dead oak branch lying on the ground in a small conifer plantation, the Discomycete *Orbilia curvatispora* Boud., which hitherto appears only to have been recorded for France and Germany; I found this fungus also at Lyndhurst, Hants., in September, 1916, during the foray.

1. *Orbilia curvatispora* Boud. (Bull. Soc. Myc. iv., p. 80, t. 16, f. 6).

Apothecia scattered or crowded, very minute, 0.6 to 1 mm. diameter, at first sub-globose then expanding and becoming more or less plane or even convex, with the rim sometimes wavy and torn; very thin and translucent when moist, white when young, becoming pale apricot when older, when dry, yellow with margin incurved and raised; excipulum glabrous parenchymatous, cell-walls very thin and delicate; asci cylindrical and truncate, 40-45 × 3-4μ, spores 8, filiform and spirally curved, 10-15 × 1μ; paraphyses simple or forked at the base, septate, 1.5μ wide, apices rounded and obovate 3-4μ wide (figs. 1-6).

On decaying oak branches under trees.

Rehm (Rabenh. Krypt. Flora. Pilze. Band 1, Abtheil 3, p. 458) comments on the colour as given by Boudier "hyalina alba, vix lutescentia," remarking that the yellow colour was the more predominant in his specimens: this is so with mine, the majority inclining to a pale apricot colour, the younger ones only being hyaline and white. He also draws attention to the knobbed paraphyses and figures them, remarking on the egg-like form of the swollen tips comparing them to conidia; in my specimens the tips are swollen, but the swelling is obovate (fig. 4), not ovate as in Rehm's figure, and the swellings rarely resemble conidia since they are seldom separated from the stalk part of the paraphysis by a cell-wall, also the transition from knob to stalk is very gradual and not abrupt as seen in the diagram by Rehm. The curved spores (fig. 5) are very characteristic and look

rather like large bacteria of the spirillum type; they are not easy to distinguish when in the asci. These minute discs can stand quite low temperatures, for although flourishing in a cold June a few were still living and in good condition on the log after a week's frost at the end of December. Among the numerous apothecia that I examined I came across the curious abnormality of three small apothecia forming on the disc of a large full-grown apothecium, part of the hymenium of which had been nibbled away by some insect, probably by some species of *Orchesella* which I have seen feeding on this and also on other Discomycetes.

2. *Belonidium pineum* Bonord. Comb. nov.*

In November, 1916, I found in my garden growing on fallen pine-cones a *Belonidium*, which I consider the same as *Sarea pinea* (*Helotium pineum* Sacc.) recorded by Bonorden for Westphalia, but which does not appear to have been seen since.

Bonorden's description is very incomplete and since he gives no spore-measurements it is impossible to be quite certain of the identity of the two fungi; but as the size and colour agree, and the peculiar paraphyses are the same, and also the habitat of the two fungi is on the pine, it seems justifiable to consider the fungus I have found on the cones of *Pinus sylvestris* as identical with the one found by Bonorden on "the inner side of pine bark."

Description:—Ascophores erumpent, scattered and stipitate; disc plane then slightly repand, yellow, becoming reddish brown when old, .75 mm. across; stem very short but wide, reddish brown; excipulum formed of interwoven hyphae running out at the margin into very short hairs; ascophores at first almost globose and reddish brown, then cylindrical with a flat yellow disc at the top which gradually widens; asci broadly clavate 110 × 20μ, pedicel long; spores 8, two seriate, smooth, hyaline, unicellular at first and sometimes multiguttulate, becoming pluriseptate, 30-35 × 8-11μ, slightly curved; paraphyses 1.5μ wide, branched widening at the tips to 4μ (figs. 7-12).

Habitat. Cones of *Pinus sylvestris*, and the inner side of pine bark.

3 and 4. *Ombrophila viridifusca* (Fuckel) Rehm and *Ombrophila alniella* (Nyl.) Boud.

In December last I picked up in Windmill Naps, Tanworth-in-Arden, several Alder catkins on which were growing two Discomycetes belonging to the genus *Ombrophila*—a sessile

* This is the *Phialea pinea* (Bon.) Boud.—C R.

form and a stalked one. On some catkins the two forms occurred together; the sessile form proved to be *Ombrophila alniella* (Nyl.) Boud. and the stalked one *Ombrophila viridifusca* (Fuckel) Rehm, a species which has not hitherto been recorded for the British Isles.

Description of *Ombrophila viridifusca.* Ascophores scattered, stipitate, clavate at first; disc concave, then plane, becoming convex with a central depression; thin, pale dingy brown, 1-3 mm. across; excipulum composed of interwoven hyphae with parenchyma beneath; hoary especially near the margin, due to the presence of hyaline hairs; stalk 1-3 mm. long × .2-.3 broad, expanding upwards, dingy brown becoming darker below; asci cylindrical 55-56 × 8μ, spores 8, two seriate, hyaline, smooth, continuous, narrowly egg-shaped, 8-11 × 4μ; paraphyses filamentous, 1μ wide not becoming broader at the ends, colourless, forked (figs. 13, 14, 15, 16, 20, 22).

This fungus is described by Rehm under the name of *Phialea viridifusca* and he remarks in an appended note that he considers it identical with *Ombrophila Baeumleri* Rehm, but since Fuckel's nomenclature has priority it should be called *Ombrophila viridifusca* (Fuckel) Rehm. A note is also appended to the description of *Ombrophila Baeumleri* to the effect that the fungus in question is synonymous with *Chlorosplenium amenticolum* Karst. and also with *Helotium amenti* v. *Alni* Sacc. However, it is, as Rehm says, undoubtedly an *Ombrophila* in consistency, and not a *Helotium,* and it also differs from *Helotium amenti* Fckl. in other particulars; it is larger, it is stalked and not sessile, the colour differs, and the paraphyses are forked and filamentous, and show no indication of thickened tips 3μ wide.

It is true the spore-measurements are very similar, being 6-9μ × 3.5-4μ for the *Helotium* compared with 7-10 × 3-4μ for the *Ombrophila.*

Fuckel himself who knew and described both fungi evidently considered them as separate species.

On examining what seemed to be the very young apothecia of *Ombrophila alniella* (fig. 21b) I found that they were really pycnidia, and that pycnospores (fig. 18) are given off from short hyphae, and that these accumulate within the pycnidium and under damp conditions when mature ooze out in a gelatinous mass, and appear as a glistening white dome on the top of it (figs. 21b and 19); when disturbed the pycnospores stream out in great profusion.

This must *ad interim* be regarded as a new genus of the Excipulaceæ.

ACLEISTIA nov. gen.

Pycnidium excipuliform, open from the beginning, composed of dark olive interwoven hyphae, margin fringed with hairs; spores roundish, colourless and continuous.

ACLEISTIA ALNIELLA.

Pycnidium gregarious, superficial, excipuliform, open from the first, round, $\frac{1}{5}$ to $\frac{1}{4}$ mm. diameter, composed of dark olive interwoven septate hyphae, margin surrounded by a fringe of colourless hairs continuous with the interwoven hyphae; pycnospores colourless, roundish oval, 2 to $2.5 \times 2\mu$, situated on the apex of unbranched sporophores, 12-15μ long, which form a lining round the interior of the pycnidium (figs. 18, 19, 21b).

Habitat: female Catkins of *Alnus glutinosa*.

Acleistia nov. gen.

Pycnidium excipuliforme, ab initio apertum, ex hyphis atro-olivaceis intertextis compositum, margine pilis fimbriato, sporulis rotundatis, achrois, continuis repletum.

Genus ad Excipulaceas attribuendum.

A. alniella, sp. n.

Pycnidia gregaria, superficialia, excipuliformia, ab initio aperta, rotundata, $\frac{1}{5}$-$\frac{1}{4}$ mm. diam., hyphis excipuli septatis, flexuosis olivaceis in pilos marginis obtusos hyalinos abeuntibus; sporulæ achroae, ovali-rotundæ, 2-2.5 $\times$ 2μ, sporophoris simplicibus, 12-15μ longis acrogenæ.

Hab. in amentis *Alni glutinosæ*, Warwickshire.

In the descriptions of *Helotium alniellum* by Massee and Phillips, I see no mention of the excipulum being hoary; this feature was very noticeable in all my specimens and was due to the very numerous rounded hair-like outgrowths with which they were covered (fig. 16), especially near the margin where they were more prominent and longer; no doubt this is what Rehm means by "bestäubt"; the paraphyses of this species are generally forked, often even trifurcate. Although the colour of the fungus is given as white or pallid white, under the microscope the excipulum is distinctly pale olive, especially near the very short stalk, and in young specimens it is very dark olive.

Rehm gives the size as 0.3-0.8 mm. and Phillips as 1-$\frac{1}{2}$ line; many of my specimens were more than a millimetre in diameter.

Both *O. viridifusca* and *O. alniella* can stand a considerable amount of freezing, for good specimens of both were ob-

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tained after frosty weather for several days, with a night temperature of 22-26 F.

I wish to express my thanks to Mr. W. B. Grove, M.A., for useful criticism and help in various ways, and to Professor G. S. West for the loan of books of reference.

DESCRIPTION OF PLATE VII.

Fig. 1. *Orbilia curvatispora.* Apothecia, young and mature forms, × 16.
,, 2. Excipulum, × 377.
,, 3. Hymenium, × 377.
,, 4. Paraphyses showing obovate apices and forking.
,, 5. Curved ascospores, × 377.
,, 6. Three young apothecia growing out of a mature apothecium which has been nibbled, × 16.
,, 7. *Belonidium pineum.* Hymenium.
,, 8. Ascospores, septate and a-septate with small and large guttules.
,, 9. Germinating ascospores, × 377.
,, 10. Apothecia growing on cone. Nat. size.
,, 11. Excipulum, × 111.
,, 12. Apothecia, erumpent; young and mature forms, × 11.
,, 13. *Ombrophila viridifusca.* Hymenium, × 377.
,, 14. Excipulum, × 188.
,, 15. Ascospores, × 377.
,, 16. *Ombrophila alniella.* Excipulum showing outstanding round hairs, × 377.
,, 17. Ascospores, × 377.
,, 18. *Acleistia alniella.* Section through pycnidium, showing fringe of pale hairs and sporophores bearing pycnospores, × 377.
,, 19. Pycnidia and pycnospores, × 60.
,, 20. Catkin of Alder, with
(a) *Ombrophila viridifusca,* × 1½.
(b) *O. alniella.*
,, 21. Scale of Alder Catkin with
(a) *O. alniella* apothecia, × 18.
(b) *Acleistia alniella* pycnidia and mucilaginous masses of pycnospores.
,, 22. *O. viridifusca* apothecia on scale of Alder, × 2⅔.

NEW OR RARE MICROFUNGI.

By A. Lorrain Smith, F.L.S., and J. Ramsbottom, M.A., F.L.S.

The writers desire to express their thanks to those who have intimated to them records of species new to Britain. It is extremely desirable that the lists published in the Transactions should be absolutely complete.

PHYCOMYCETES.

Synchytrium sanguineum Schröt. in Hedwig, xv., p. 134 (1876).

On radical leaves of *Cirsium palustre,* near Widney Manor Station, June. Recorded by Grove in Journ. Bot., liv., p. 223 (1916).

Physoderma Heleocharidis (Fuck.) Schröt. Kryptfl., iii., 1, p. 194 (1885).

On stems of *Eleocharis palustris,* Gamlingay, Cambs., July, 1916. Coll. C. E. Moss.

Syncephalis intermedia van Tiegh. in Ann. Sci. Nat., 1875, p. 127, figs. 110-5.

Previously recorded on rabbit dung, Leith Hill, Surrey. Found by W. B. Grove on crops of *Mucor* spp., on horse dung, Birmingham, March (Journ. Bot., liv., p. 222 (1916)).

Entomophthora americana Thaxter in Mem. Bost. Soc. Nat. Hist., iv., p. 179 (1888).

Conidia long-ovoid, with a broad evenly rounded apex, tapering for some distance to a papillate base, often slightly bent to one side. Within the spore are usually numerous fatty bodies often very regular in size and shape. Average measurements 28-30μ × 14μ, maximum 35 × 15μ. Conidiophores regularly digitate, arising from large, irregular, roundish hyphal bodies, and coalescing over the host in a mat-like covering which becomes slightly rust-coloured on exposure. Cystidia absent. Secondary conidia like the primary. Resting spores, colourless, hyaline, spherical;

average diameter 38-45μ, maximum 50μ. Host attached to substratum by numerous filamentous rhizoids, without terminal root-like expansions; forming an even mat-like attachment continuous around the abdomen of the host.

Diptera: U.S.A.

On *Hyedotesia erratica* Thr., Epping Forest, October, 1916. Comm.: H. Main and K. G. Blair.

PYRENOMYCETES.

Sordaria coronifera Grove in Journ. Bot., liv., p. 185 (1916).

On horse-dung, Earlswood, near Birmingham, Oct.

Sphaerella elodes n. sp.

Peritheciis epiphyllis, nigris, confertis, subglobosis, parum immersis, 100-150μ latis, poro pertusis; ascis oblongis, breviter stipitatis, 8-sporis, c. 45μ longis, 7-8μ latis; paraphysibus nullis; sporis bi-serialiter stipatis, oblongo-fusiformibus, leniter curvatis, 1-septatis, non-constrictis, hyalinis, 15-18μ longis, 2-3μ crassis. In foliis languidis *Hyperici elodis*.

Collected in the New Forest, Sept., 1916.

Diaporthe stictostoma Sacc. (Grove l. c.)

On twigs of apple, originally prepared for grafting, Bristol, Oct. (Comm. A. D. Cotton).

Leptosphaeria Fuckelii Niessl (Grove Tom. cit., p. 186).

On the lower part of old culms of *Phalaris arundinacea variegata,* in a garden, Burcot, near Bromsgrove (Warwick).

L. (Pocosphaeria) pellita Sacc. var. *cirsiicola* Grove, l. c.

In dead stems of *Cirsium arvense,* Glengariff, Ireland, spring.

HYSTERIACEAE.

Hypoderma scirpinum DC., Flor. franç., vi., p. 166 (1815).

Apothecia generally numerous, sometimes coherent, in light coloured spots of the stalk, somewhat parallel, immersed becoming superficial, elongate-ellipsoid, straight, rarely bent, shining black, 2-4 × .6-1 mm, opening by a narrow slit; asci elongate-clavate, slightly narrower at the tip and with a long slender stalk, 120-150 × 15-17μ, octosporous; spores cylindrical-fusiform, often slightly bent, uniseptate, hyaline, 36-56 × 5-6μ, massed in the upper portion of the ascus; paraphyses filiform, septate, c. 2μ broad, somewhat flexuous above, colourless.

On decaying stalks of *Scirpus lacustris*, Loch Fergus, Ayr, Aug., 1914. Comm. D. A. Boyd.

According to Rehm the spores measure only up to 40μ long. In our specimen they are constantly 50μ or rather more, which agrees more nearly with Saccardo's measurement as recorded.

GYMNOASCACEAE.

GYMNOASCUS SUBUMBRINUS n. sp.

Glomerulis globosis, ad 500μ latis, fulvo-umbrinis; filamentis peridii irregulariter ramosis, saepe anastomosantibus, fenestratis; hyphis laevibus, brunneis, ad apices interdum hyalinis, septatis, 4-5μ latis; ascis globosis, 7-8μ crassis; sporis sphaericis, laevibus, hyalinis vel demum fulventibus, 3-4μ crassis.

Ad terram cum *Isaria farinosa* associatus.

This species is closely allied to G. umbrinus Boud. but differs in the larger size, the almost entirely smooth anastomosing filaments of the peridium, and in the smaller asci. The fungus appeared in the laboratory on soil originally brought from Chiswick by Mr. G. F. Hook, in which had been grown a caterpillar that became infected with Isaria.

SPHAEROPSIDEAE.

Phyllosticta nuptialis Thüm. Contr. Myc. Lusit.; Sacc. Syll., iii., p. 9 (1884).

Leaf spots roundish, becoming ochraceous, white on drying, surrounded by a purple zone, the under side of the leaf blackish. Pycnidia mostly epiphyllous, scattered or sometimes confluent, conical, black, at first covered by the epidermis, then free and soon dropping out; spores very small, almost globose or ovate, 2-2.5μ × 1.5μ.

On living leaves of *Myrtus communis*. Collected at Torquay by A. Gepp.

Phyllosticta Ilicis Allescher in Rabenh. Krypt. Fl., vi., I., p. 49 (1901); *Phoma Ilicis* Desm. Exs., No. 1290.

Spots greyish white. Pycnidia amphigenous, punctiform, immersed, globose, brown then black, slightly projecting, 150-200μ in diam, opening above by a pore: spores oblong or narrowly ellipsoid, often biguttulate, 12-15μ × 2-3μ.

On fading leaves of *Ilex Aquifolium*. St. Annes-on-Sea, Lancashire, July, 1916.

This fungus has been previously recorded for Britain by W. B. Grove in Journ. Bot., xxiii., p. 162 (1885), as *Phoma*

Ilicis. The above description, drawn up from our specimen, differs from the description of Saccardo (Mich. I., p. 525 (1879)) and Allescher, in the form of the spores which taper slightly at the ends. Mr. Grove gives spore sizes up to 16-18μ in length.

A second species occurring on the leaves of Ilex Aquifolium has been named *Phyllosticta Ilicis* by Oudeman (Contrib. Fl. Mycol. Pays-Bas., xvii., p. 226 (1901)). It is evidently a distinct species, as among other characters the spore sizes differ considerably. It agrees more nearly with *P. Haynaldii* Roum. et Sacc.

Phoma rubiginosa Brun. var. *circumstipata* Grove Tom. cit., p. 186.

On sarmenta of *Rosa canina,* Lapworth, Warwick, May.

P. Lavandulae Gabot. (Grove Tom. cit., p. 187).

On stems of Lavender, Kew Gardens, August.

P. lirelliformis Sacc. var. *aucubicola* Brun. (Grove l. c.)

On dead branches of *Aucuba japonica,* Botanic Gardens, Birmingham, March.

P. striaeformis Dur. et Mont. var. *hysteriola* Sacc. (Grove Tom. cit., p. 188.)

On stem of *Chaerophyllum temulum,* Storeton, Cheshire, March (Dr. J. W. Ellis).

P. iridina Maire & Sacc. (Grove l. c.)

On dead bleached flower-stalks of *Iris Pseudacorus,* Quarry Pool, Hamstead, Staffs., April.

P. cinerascens Sacc. in Mich. i., p. 521 (1879).

On branches of fig-trees at Sompting, Sussex, and in glass-houses, Wisley. Salmon and Wormald in Ann. Appl. Biol. iii., p. 3 (1916).

Sphaeronaema cornutum Preuss. (Grove Tom. cit., p. 189).

On dead wood, Sutton Coldfield, 1885. On soft decaying wood (?willow), Windmill Naps, Tanworth, January-May (Dr. Bayliss-Elliott).

Fusicoccum Aceris Grove l. c.

On branches of *Acer,* Cheshire. April (Dr. J. W. Ellis).

F. gloeosporoides Sacc. et Roum. (Grove l. c.)

On twigs of *Corylus Avellana,* Cheshire. April (Dr. J. W. Ellis).

F. quercinum Sacc. (Grove l. c.)

On twigs of oak, near Malvern. May. (Dr. J. W. Ellis).

Cytospora Euonymi Cooke in Grev., xiv., p. 4 (1885); Diedicke in Krypt. Fl., Mark Brandenb., ix., 2, p. 341 (1912).

Stromata densely gregarious covering large brown portions of the branch, divided below into several irregularly arranged chambers which converge into a common cavity and emerge as a conical ostiole; spores cylindrical, bent, 5-7 × 1-1.5μ; conidiophores crowded, mostly simple, 15-25 × 1μ.

On dead branches of *Euonymus japonicus,* Wisley, Surrey, June, 1916.

The fungus was first recorded on *Euonymus americanus* from Kew; later on *E. europaea* in Thuringia.

Cytospora stictostoma Grove l. c.

On branches of *Pyrus Malus,* Bristol, together with *Diaporthe stictostoma* Sacc.

Coniothyrium Ilicis n. sp.

Matrice dealbata; pycnidiis congregatis, epiphyllis, fuscis dein nigris, immersis, prominulis, papillatis c. 150-200μ diam.; sporis ellipsoideo-globosis, pallide-brunneis, eguttulatis, 3-5 × 2-3μ.

In foliis languescentibus *Ilicis Aquifoliae.* St. Annes-on-Sea, Lancashire, July, 1916.

The dimensions of the above species do not differ materially from those of *Coniothyrium Yerbae, C. maticola* and *C. Mate,* all described by Spegazzini, on decaying branches of *Ilex paraguariensis* in the Argentine and scarcely distinct from each other. These latter differ from the British species not only in the host but in the much lighter coloured spores.

Ascochyta Plantaginis Sacc. et Speg. in Michelia I., p. 166 (1877).

Spots variously formed becoming brown on drying; pycnidia congregate, lentiform, 100-150μ in diam, with a rather wide prominent ostiole, and the outer wall of rather large cells, reddish-olive coloured; spores elongate or almost

ellipsoid, blunt at the ends, sometimes slightly bent, uniseptate, guttulate, 7-12 × 2.5-3μ.

On living leaves of *Plantago major.*

Between Denham and Uxbridge (Middlesex), June, 1916.

Ascochyta Vincae Grove Tom. cit., p. 191.

On leaves of *Vinca major,* Ledbury. March.

Ceuthospora Euonymi Grove Tom. cit., p. 190.

On leaves and branches of *Euonymus japonicus,* Wallasey, Cheshire, September-December (Miss B. O'Loughlin); Southampton, March (J. F. Rayner).

The stromata are dimorphous, one form being unilocular, the other plurilocular. "The two forms of conceptacles stand to each other exactly in the same relation as *Cytospora Laurocerasi* Fckl. to *Ceuthospora Lauri* Grev., which should equally be regarded as one species." For this latter species on *Prunus Laurocerasus* Grove suggests the name *Ceuthospora Laurocerasi* comb. nov., holding it to be "clearly justifiable to choose the more accurate specific name, and drop the prior misleading one, for a false name, given in error, should not be allowed to carry any rights of priority."

It may be pointed out that although Greville in his Flora Crypt. referred his "common laurel" of Flora Edin., p. 361, to *Laurus nobilis*—as Berkeley pointed out in Engl. Fl., v., p. 283 (1836)—Sowerby was the first to use the specific name *Lauri* (Sphaeria Lauri t. 371, f. 4) for this fungus on *Prunus Laurocerasus* without specifying the host plant, although the figure is obviously not that of *Laurus.*

Vide supra *Cytospora Euonymi* Cooke.

Diplodina laminariana Sutherl. in New Phytol. xv., p. 39 (1916).

Saprophytic on fronds of species of *Laminaria* along the coasts of Ayrshire, Dorset and Orkney—probably general.

"The dimensions and description of this fungus show similarity to those given by Cooke and Massee for *Phoma Laminariae.* As the spores of Diplodina are continuous almost until maturity, and may be expelled in this unicellular state, it is possible that the two are identical. A distinctly different *Phoma* has been met with on *Laminaria* fronds but it is of much more restricted distribution. Its spores are smaller—being only about half the size—and consequently differ from *Phoma Laminariae.* . . . . Unfortunately a type specimen of the original *Phoma* has not been available, and consequently its connection with *Diplodina* and the smaller-spored *Phoma* could not be determined.

" With reference to the naming of the species under consideration, a distinct disadvantage of the present artificial system, adopted with regard to pairs of genera like *Phyllosticta* and *Phoma,* or *Ascochyta* and *Diplodina,* may be noted. A generic description, based almost entirely on occurrence on the leaves in spots or on the stems, while applicable to fungi on higher plants, breaks down when it has to be applied to those occurring on Thallophyta. . . . . In the present instance, ... the distinction laid down by Diediche in the pycnidial walls of *Ascochyta* and *Diplodina* has been adopted in order to place this species in conformity with the existing classification."

Diplodina Passerinii Allesch. (Grove Tom. cit., p. 191).

On base of stems of *Antirrhinum,* Birmingham, May.

Diplodia inquinans Westend. Not. II., p. 14 (1851).

Pycnidia densely congregated, emersed then raising and bursting the epidermis, subglobose, thick-walled, imperfectly chambered with a distinct ostiole, c. 5 mm. in diam.; spores ellipsoid or elongate, blunt at the ends, straight or somewhat bent, often subclavate, one celled and brown then uniseptate, sometimes more or less constricted, with several large oil drops, 20-25 × 12-14μ; Sporophores slender, 15 × 2μ.

On dead bark of *Fraxinus excelsior,* West Kilbride, Ayrshire, Sept., 1914. Coll. D. A. Boyd.

Diplodia Saccardiana Speg. var. *anglica* Grove Tom. cit., p. 192.

On dead branches of *Sarothamnus scoparius,* Caughley, Salop, May (Dr. J. W. Ellis).

Stagonospora salicicola Sacc. & Trav. Syll. xix., p. 879. *Tetradia salicicola* Johns. in Proc. Roy. Dubl. Soc. N. Ser. x., p. 157, t. 13, figs. 3-4 (1904).

On branches of *Salix triandra,* Ireland.

Hendersonia tarda Grove. Tom. cit., p. 217.

On dead leaves of *Ilex Aquifolium,* Hereford. February.

H. mollis Grove l. c.

On dead vagina of a grass (?*Melica*), Ledbury. May.

H. Letendreana Sacc. f. *Dipsaci* Grove l. c.

On dead stems of *Dipsacus silvestris,* Credenhill Camp, Hereford. June.

H. tenella Schröt. (Grove Tom. cit., p. 218).

On old rotting stems of *Saponaria officinalis,* Hartlebury Common. May.

Camarosporium rubicolum Sacc. (Grove l. c.)

On stems of *Rubus,* Shustoke, April, 1888. On young sarmenta of *Rubus discolor,* Hereford. March.

Septoria Bellidis Desm. et Rob.

On leaves of "hen and chickens" daises (*Bellis perennis* var.), Richmond, Surrey, June, 1916; Blackpool, July, 1916. *Cf.* Trans. Brit. Mycol. Soc., v., p. 160 (1915).

S. staganosporioides Massal. Nuova contr. mic. Veron. In Malpighia, viii., p. 200 (1894).

Spots almost lacking. Pycnidia black, densely scattered over the underleaf surface, lens-shaped, 140-200μ in diam.; spores 15-20μ, guttulate, greenish-yellow.

On fallen leaves of *Prunus Laurocerasus.*
Coll. A. Gepp, Torquay, July, 1916.

S. oxyspora Penz. et Sacc. var. *culmorum* Grove Tom. cit., p. 192.

On culms of *Dactylis glomerata,* Burcot, nr. Bromsgrove (Warwicks.), together with *Leptosphaeria microscopica,* etc.

Leptothyrium Platanoides Pass. (Grove Tom. cit., p. 219).

On living leaves of seedling Sycamores, Park Mill, Gower Peninsula, September (Dr. J. W. Ellis). Himley Park, Staffs., October.

Leptostroma spiracinum Vestergr. (Grove l. c.)

On dead stems of *SpiraeaUlmaria* and various cultivated species of *Spiraea; Raby, Cheshire* (Dr. J. W. Ellis); Sutton Coldfield; Studley. March-June.

MELANCONIACEAE.

Gloeosporium Aristoteliae n. sp.

Maculis longis, angustis, ad folii marginem dispositis, fuscescentibus, purpureo-marginatis; acervulis numerosis, gregariis, amphigenis, nigris, c. 150-170μ diam.; sporophoris variantibus c. 25μ longis, 5μ crassis; hyalinis dein plerumque brunneis; sporis hyalinis, ellipsoideis, deorsum saepe angustioribus, 3-6μ longis, 2μ crassis.

In foliis vivis *Aristoteliae Macqui.* Torquay, May, 1916. Leg. A. Gepp.

Colletotrichum Lineola Corda.

On sheaths and culms of *Dactylis,* Olton, June.

C. Lineola Corda var. *Phragmitis* Grove.

On culms of *Phragmitis,* Moreton, Cheshire. April (Dr. J. W. Ellis).

C. Volutella Sacc.

On dead stems of *Rubus fruticosus,* Thurlaston, Cheshire, July (Dr. J. W. Ellis).

C. Orchidearum Allesch. Rabenh. Krypt.-Fl., i., 7, p. 563 (1903).

Acervuli on both sides of the leaf, immersed, then bursting the epidermis, small, round, black; hairs simple, straight or slightly bent, thinly septate, tapering upwards, dark brown, 50-100μ × 3-5μ; Sporophores clustered, short, thick, dark at the base; spores elongate or almost cylindrical, rounded at the ends, granular or guttulate, almost colourless, 12-20μ × 4-6μ.

Parasitic on species of *Oberonia* and other orchids (det. E. Wakefield in The Orchid Review, xxiv., p. 283 (1916).

HYPHOMYCETES.

Fusidium maritimum Sutherl. in New Phytol., xv., p. 41 (fig. 3, 1-2) (1916).

Saprophytic on *Laminaria* fronds and *Pelvetia* thalli. Orkney and Dorset. "This species of *Fusidium* occurs both on fronds collected above high tide mark and on decaying thalli periodically submerged."

Sterigmatocystis sulphurea Fres. (Grove Tom. cit., p. 220).

Forming effused roundish patches on a rotting fabric, Scarborough, July. (T. B. Roe).

Sporotrichum maritimum Sutherl. in New Phytol., xv., p. 43 (1916).

On *Laminaria* fronds. Dorset.

Monosporium maritimum Sutherl. Tom. cit., p. 42, fig. 3, 3-5.

Saprophytic on decaying seaweed. Dorset.

"The characteristic, irregular, pulvinate masses of this fungus are to be found wherever *Laminaria* fronds are decaying under fairly moist conditions."

DIPLOOSPORA Grove in Journ. Bot., liv., p. 220 (1916).

Conidia uniseptate, catenulate, more or less ovoid, subhyaline, borne on short erect hyphae rising from creeping mycelium.

D. rosea Grove l. c.

On damp paper, Scarborough, July, 1913. (Leg. T. B. Roe).

Dactylella plumicola Grove in Journ. Bot., liv., p. 220 (1916).

Forming yellowish spots on rotting feathers, half-buried in soil. Birmingham, March, 1914.

Ramularia sambucina Sacc. Syll., iv., p. 197.

On leaflets of *Sambucus nigra,* abundant, Studley Castle, July.

Recorded by W. B. Grove in Journ. Bot., liv., p. 221 (1916). Headingly, Surrey.

R. Ari Fautr. in Rev. Mycol., 1892, p. 176.

On leaves of *Arum maculatum,* near Conway, Old Penmaenmawr Road (J. W. Ellis); Studley; Berkswell; Ledbury. Recorded by W. B. Grove, l.c.

Ramularia lactea Sacc. Fungi Ital., t. 996 (1881). *Fusisporium lacteum* Desm. in Ann. Sci. Nat., ser. 3, xiv., p. 109 (1850).

Leaf-spots almost circular, about 5 mm. across or larger, brownish, becoming lighter in colour. Tufts on both surfaces, emerging from the stomata, of slender somewhat bent conidiophores; conidia elongate-ovate, fusiform or cylindrical and blunt at the ends, mostly 1-celled, more rarely 1-septate, sometimes in chains, colourless, 7-20μ long, 2-3μ thick.

On leaves of *Viola Riviniana.* New Forest, Sept., 1916.

Ramularia violae Trail (? Fuck.), recorded in Trans., iii., p. 121, does not differ from the above except in the form of the conidiophores and in the larger leaf-spots. The differences may only represent different conditions of growth.

Ramularia Cardui Karst. in Meddel. Soc. Faun. & Fl. Fenn., xiv., p. 109 (1888).

Spots on leaves large, from .5 cm. to several centimetres long, roundish, white, with a brown border, often finally

falling out. Tufts epiphyllous, dense. Conidiophores arising in dense clusters from the stomata, unbranched, mostly two-celled with the upper cell undulate or bent in the manner of a cork-screw, hyaline, 45-70μ long × 4-5μ wide. Conidia rod-shaped, usually continuous, seldom one-septate, hyaline, often forming chains, 10-22μ × 2-5μ.

On fading leaves of *Carduus crispus*. Also on *C. nutans*. Collected by D. A. Boyd on fading leaves of *Carduus (Cirsium) arvensis*, West Kilbride, Ayrshire, Sept., 1915.

The fungus differs from *R. Cirsii* Allesch. in the size and shape of the conidiophores and of the spores.

Hormiscium callisporum Grove in Journ. Bot., l., p. 16 (1912) and op. cit., liv., p. 221 (1916).

On stems of *Conium maculatum*, Hereford, May, 1914.

Acrotheca acuta Grove in Journ. Bot., liv., p. 222 (1916).

On decayed decorticated stalks of *Urtica dioica* towards the base near and on the perithecia of *Leptosphaeria acuta*, Hereford, May.

Trichosporium calcigenum (Link) Sacc. Syll. iv., p. 295. (Grove Tom. cit., p. 221).

On damp white-washed walls, at the Botanic Gardens, Edgbaston, Birmingham. Jan., 1915.

Cercospora salina Sutherl. in New Phytol., xv., p. 43, fig. 4 (1916).

Saprophytic on various seaweeds along the coast of Aberdeen, Ayrshire, Dorset and Orkney.

"*Cercospora* plays very much the same part along the tidal zone that *Cladosporium* [algarum] does above it. Like the latter, it is widely distributed, and its conidia and mycelium may be found in almost any piece of decaying seaweed picked up from rock-pool or beach. . . . .

"*Cercospora salina* responds to culture conditions and grows luxuriantly on agar extract of almost any sea-weed. Naturally the conidia also germinate readily in salt water, but there the development of mycelium is very slight. If it fails to find a suitable sub-stratum it proceeds to form conidia of an extremely long, attenuated type. These are nearly hyaline and borne at the end of short conidiophores tinged with light yellow. Frequently such conidia proceed directly to form other short fertile branches terminating in similar types.

"In many cases terminal or lateral swellings have been

noticed on the mycelium. These increase in size and become divided by septa. In vigorously growing cultures, abundantly supplied with food material, some of these have been seen to form starting points for the development of fertile branches. They usually contain darker contents than the adjoining hyphae. . . . .

"When grown on dry material above tide mark, the dark, stout thick-walled conidia might be regarded as belonging to *Helminthosporium,* but the type and habit of conidiophore, as well as the arrangement of conidia is distinctly that of *Cercospora.*"

Macrosporium laminarianum Sutherl. Tom. cit., p. 45 (fig. 5, 1-4).

Saprophytic on fronds of *Laminaria,* Dorset and Orkney.

Alternaria maritima Sutherl. Tom. cit., p. 46 (fig. 5, 5-7).

Saprophytic on *Laminaria* fronds, Ayrshire Orkney and Dorset.

Epicoccum maritimum Sutherl. Tom. cit., p. 47 (fig. 5, 8-10).

Saprophytic on *Laminaria* fronds, Dorset and Orkney.

Sclerococcum Fr. Syst. Orb. veg., i., p. 172 (1825).

Acervulae almost perithecia-like, firm, black, superficial, naked; conidia ellipsoid, septate, dark brown. Parasitic on Lichen thalli.

S. sphaerale Fr. op. cit.; Syst. veg. iii., p. 257 (1829).

Acervulae almost globose, sphaeria-like, scattered, $\frac{1}{5}$-$\frac{1}{3}$ mm. in diameter, somewhat horny, smooth, black; conidia septate, the individual cells becoming separate and globose, c. 6μ in diameter, occasionally in groups of four.

On the thallus of *Pertusaria dealbata,* Ochill Hills, near Stirling. Ex herb. J. M. Crombie, and on *Diploschistes bryophila* on rocks, Barmouth, ex herb. T. Salwey.

NEW OR RARE BRITISH FUNGI.

With Plate VIII.

By Carleton Rea, B.C.L., M.A., &c.

Amanita phalloides (Vaill.) Fr. var. *umbrina* (Ferry) Maire. Maire les champ. vén. d'Algérie, Bull. Soc. d'Hist. Nat. de l'Afrique du Nord vii. (1916), 143.

This variety is characterized by the umber brown pileus and the fuscous, adpressed squamules on the stem. On the ground, Alderminster, Worcestershire, 11th October, 1916, Rev. J. Harvey Bloom.

Lepiota castanea Quél. Quél. As. fr. (1880), t. 8, fig. 1. Quél. Fl. Myc., 299.

Pileus 1-3cm. wide, *reddish brown,* campanulate, often umbonate, *tomentose, then shaggy.* Stem 3-4cm. long, 3-4mm. thick, *white, becoming concolorous* with the *tawny fibrils,* firm, base bulbous. Ring *white, tawny on the outside,* narrow, thin, membranaceous, silky, fugacious. Gills *cream colour,* often tinged reddish when old, free, ventricose, Flesh *cream colour, becoming reddish in the stem, and occasionally in the pileus.* Spores white, oblong, elliptical, often with a spine-like appendage on the one side, 10-11 × 3·5-4·5μ, 1-2-guttulate. Smell pleasant. Poisonous.

On the ground in a lane at Claygate, Surrey, 17th September, 1916, Mr. A. A. Pearson.

Easily known by the deep reddish chestnut, tomentose pileus and the spur-like appendage to the spore.

Tricholoma unguentatum Fr. Fr. Hym. Eur. 57. Fr. Icon. t. 31, fig. 1.

Buckden, Naturalist* (1917), 131.

Hygrophorus obscuratus Karst. Karst. Hedwigia (1889) 364.

Buckden, Naturalist (1917), 131.

* These are bare records unaccompanied by any notes.

Russula punctata (Gillet) Maire. Bull. Soc. Myc. Fr. xxvi. (1910), 116.

Pileus 3-8cm. wide, *rose, purple, purple-violaceous, lilac, often more or less mixed with olive green or yellowish green, sometimes entirely greenish olive, yellowish green, or yellow citron colour,* fleshy, convex, then plane, sometimes slightly depressed, either *viscid or dry, granularly mealy, often punctate with deeper coloured granules;* margin sometimes somewhat sulcate when old. Stem 3-5cm. long, .5-1.5cm. thick, *rose, purple, purple-violaceous, often partially or quite white,* equal, or obconic, *pruinosely mealy,* sometimes rugosely striate. Gills *whitish cream, then cream colour,* adnate or subadnate, *edge sometimes purple, or purplish-violaceous, and floccose,* either throughout its length or near the margin of the pileus only, thin, crowded, often forked at the base. Flesh white, sometimes reddish near the cuticle of the pileus. Spores whitish cream in the mass, somewhat hyaline under the microscope, elliptical, 7.5-9 × 7-8μ, verrucose, subreticulate. Smell slight or very pleasant. Taste mild. Edible.

Wimbledon Common, New Forest and Wyre Forest, Sept.-Oct., 1916.

var. *violeipes* (Quél.) Maire. Maire l. c., 118.

Differs from the type in the *citron yellow pileus sometimes tinged with lilac, and the white tinged with lilac or lilac stem.* Wimbledon Common and New Forest, Sept., 1916. Many specimens exactly agreeing with Professor René Maire's extended description of this species as set out above, were found during the past year.

MARASMIUS PRUINATUS Rea. Vide t. viii.

Pileus 5-10mm. latus, *albus, demum flavescens, carnoso-corneus,* tenax, convexus, obtusus, vel obsolete papillatus, *pruinosus;* margine tenui, involuto. Stipes 1.5-3 cm. longus, 1-2mm. crassus, *albus,* equalis, minute fistulosus, rigidus, tenax, *pruinosus,* basi albo-villosus. Lamellae *candidae,* decurrentes, angustissimae, 1mm. latae, subdistantes Caro *pallide cinerea, tenacissima, elastica.* Sporae hyalinae, fusoideo-ventricosae, 9-12 × 4μ, 1-guttulatae. Ad terram inter muscos in quercetis, West Porlock, Somerset. Legit Norman G. Hadden, 14.x.1916. Easily known by the densely pruinose pileus and stem, the very tough, elastic consistency, the grey flesh, and the pip-shaped spores which are elongated into a long acute point at the one end and somewhat blunt at the other end and contain a large central gutta.

CRINIPELLIS Pat. Pat ap. Morot, Journ. Bot. (1889), 336. Essai taxonomique des Hyménomycètes, 143.

This genus differs from Marasmius in having the surface of the pileus covered with long, thick, tough, decumbent cells.

Crinipellis caulicinalis (Bull.) Rea (= *Marasmius caulicinalis* (Bull.) Quél.)

Pileus 10-15 mm. wide, *tan or fawn colour,* campanulate, then convex, thin, *delicately tomentose and pubescent.* Stem 2-3 cm. long, 2-3 mm. thick, concolorous, brown at the attenuated base, fibrous, *pubescent.* Gills *whitish yellow, then tan,* free, ventricose, thick. Flesh *tan colour,* thin. Spores white, pip-shaped, 7-8 × 5μ, punctate, 1-guttulate.

On dead grass stems in woods and on hedge banks. August to October.

Crinipellis stipitarius (Fr.) Pat. (= *Collybia stipitaria* Fr.), differs in the darker, zoned, membranaceous, umbonate pileus, the white margin and channelled stem.

Entoloma dichroum (Pers.) Fr. Pers. Syn. 343. Fr. Hym. Eur. 194. Fr. Monogr. I., 273.

Buckden, Naturalist (1917), 131.

Nolanea vinacea Fr. Fr. Hym. Eur. 208. Fr. Monogr. I., 295.

Buckden, Naturalist (1917), 131.

Hebeloma diffractum Fr. Fr. Hym. Eur. 242. Fr. Icon., t. 114, fig. 1.

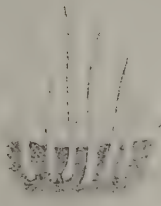
Buckden, Naturalist (1917), 131.

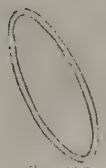
CORTINARIUS (INOLOMA) FUSCO-TINCTUS Rea. Vide t. viii.

Pileus 2-6 cm. latus, *pallide ochraceus, tactu passim rubescens dein mox fuscescens praecipue circa marginem,* carnosus, compactus, convexus, subgibbus, *sericeo-fibrillosus,* disco sub lente minute floccoso-sqamulosus; margine primitus cortinato, involuto. Stipes 6-10 cm. longus, 5-10 mm. crassus, *concolor, tactu rubescens dein mox fuscescens,* solidus, tenax, fusiformus, saepe ad basim incurvatus, apice minute albo-pruinosus. Cortina alba, manifesta, media, demum fugax, Lamellae *argillacea,* dein pallide cinnamomeae, sinuato-adnatae, antice attenuatae, 4-6 mm. latae, confertae, acie inaequales albae. Caro alba immutabilis, linea cornea ad basim lamellarum, firma, inodora et insapora. Sporae in cumulo ferrugineae, sub micr. pallide ferrugineae, ellipticae,

Marasmius prunatus Rea.

Cortinarius (Inoloma) fuscotinctus Rea.





Ascospore 21×9μ

Lasiobolus macrotrichus Rea

E A Rea del.

Mintorn W.S. & Co. Lith. Newman & Co.

9-10 × 5μ, intus minutissimae granulosae. Gregarius, in quercetis ad terram. Nunnery Wood, Worcester, 14.ix.1916. C.R.

Characterized by the pale ochraceous pileus and stem becoming reddish then blackish or fuscous when touched or bruised. This change of colour is present only in the cuticle of the pileus and stem and does not extend to the flesh. More than a score of specimens were collected, and all exhibited this feature. When stained with reddish, the plants looked like *Collybia maculata*.

Hypholoma irroratum Karst.

Buckden, Naturalist (1917), 131.

Boletus sanguineus With. emend. Quél. Withering Arr. Brit. Pl. ed. 3, iv., 319.

" Pileus about 2¼in. in diam., brightish crimson, becoming brownish in the centre, almost flat, firm, dull, (not shiny), dry, surface, under a strong lens, rough in appearance, margin almost even. Stem about ¾in. thick in the middle, slightly bulbous, about 2½in. long, of a yellowish colour below, covered with a brownish colour tinged here and there with crimson, rather punctate, with minute crimson dots, and with traces of long reticulations above. Pores dullish yellow, smallish, slightly depressed round the stem, turning blue when bruised; tubes about $\frac{5}{16}$ of an in. long. Flesh of both stem and pileus yellow, turning bluish when cut or broken.

" Growing three or four in a group, near together, in a grass-field, about 3¼in. high; not near any trees, a few yards from the end of the remains of a thorn fence south of Ryston Hall, near Downham, Norfolk, 1st July, 1916."

For the above diagnosis and determination of this rare plant, I am indebted to our member, Mr. Cecil H. Spencer Perceval.

Stereum Chailletii (Pers.) Fr. See page 252.

Dr. A. Adams informs me that he made an error in stating that his specimens were collected on an oak trunk and is now convinced that they grew on a *felled fir trunk*.

Clavaria flava (Schæff.)Fr. Fr. Syst. Myc. I., 467.

This somewhat rare Clavaria was found growing in two large rings at the New Forest Foray. It is easily known by the *brittle, sulphur yellow branches, and the trunk turns blood red when bruised or handled*. The spores are pale och-

raceous when deposited in the mass, oblong elliptical, 9-12 × 4-5μ, minutely warted.

Clavaria botrytis (*Pers.*) Fr.

In addition to the red apices of the branchlets that characterize this species when in full growth but which disappear with age, the plant may be readily identified by the *large, ochraceous, longitudinally striate spores and the very pleasant fruity smell.* The spores are ochraceous when deposited in the mass, oblong elliptical, attenuated at the base into a slightly curved point, 12-15 × 4-5μ, longitudinally striate when mature.

Battarrea phalloides (Dicks.) Pers.

Miss E. F. Noel found a fresh specimen growing in a hollow tree at Temple Guiting, Gloucestershire, on the 5th of October, 1915. This rare fungus has been only recorded from ten British stations, namely: Bungay and Yoxford, Suffolk; Earsham, Kirby, Norwich and Stoke, Norfolk; New Brighton, Cheshire; Nork, near Epsom, Surrey; Wickham, Kent; and Dropmore, Bucks. Journ. Bot., liv. (1916), 105, 145, 198.

Uromyces Onobrychidis (Desm.) Lév. Ann. Sci. Nat. 3 ser., viii. (1847), 371. Sydow Monographia Uredinearum II., 118.

Uredospores. Sori amphigenous, scattered, minute, here and there confluent, and larger, soon naked, pulverulent, cinnamon; spores globose, subglobose, or elliptical, sparsely echinulate, pallid brown, 18-32 × 15-22μ, epispore 1.5μ thick, generally with three germ-pores.

Teleutospores. Sori similar, darker in colour, spores globose, subglobose, or elliptical, with a minute low apical papilla minutely punctate or verrucose, brown, 20-24 × 17-21μ; pedicels short, deciduous.

On leaves of *Onobrychis viciaefolia,* Guildford, September, 1915. Mr. Norman G. Hadden. In this gathering only the uredo-form was obtained. The deep yellow uredospores were strongly echinulate and varied from globose to elliptical, 22-30 × 18-22μ, with an epispore 2μ thick.

Uromyces sparsus (K. et Sch.) Lév. Lév. Ann. Sci. Nat. 3 ser., viii. (1847), 369.

On leaves of *Spergularia salina,* Porlock Marsh, Somerset, June-September, 1916, Mr. Norman G. Hadden. Only the

uredo-form was collected and the spores varied from globose to oblong-elliptic, 15-30 × 15-21μ, minutely asperate.

Uromyces Salicorniae (DC.) de Bary. Rabenh. Krypt. fl. I., i., 156.

Teleutospores on stems of *Salicornia europaea,* Porlock, Somerset, 24th September, 1916, Mr. Norman G. Hadden.

Puccinia Epilobii DC. DC. Fl. fr. vi., 61.

On leaves of *Epilobium palustre,* West Myne, near Minehead, Somerset, 29th June, 1916, Mr. Norman G. Hadden. The brown teleutospores were distinctly echinulate, oblong eliptical, 33-37 × 18-20μ.

Puccinia Cardui-pycnocephali Syd. Sydow Monographia Uredinearum I., 34.

On leaves of *Carduus pycnocephalus,* Minehead Warren, Somerset, May, 1916, Mr. Norman G. Hadden. The teleutosori are very dark, almost black.

Puccinia Sonchi Roberge. Desm. Ann. Sci. Nat., 3 ser., xi., 274.

Uredospores on leaves of *Sonchus oleraceus,* Porlock, Somerset, June, 1916, Mr. Norman G. Hadden.

Puccinia sylvatica Schroet. Cohn. Beitr. III., 68.

Aecidia on leaves of *Taraxacum officinale,* Porlock, Somerset, May, 1916, Mr. Norman G. Hadden. The aecidiospores appeared quite smooth under a Zeiss J. immersion objective.

Galactinia praetervisa (Bres.) Boud. Boud. Icon. II., t. 292, iv., 161. Bres. Malp., xi., 745, and Fung. Trid. t. 216, fig. 2, II., 105, as *Peziza praetervisa* Bres.

Ascophores 1-3 cm. wide, sessile, cup-shaped, then expanded, sometimes split at the margin, hymenium more or less undulate, brownish purple; externally pale, blue or cinereous, glabrous. Flesh concolorous, becoming whitish. Asci thin, cylindrical, attenuated downwards, 270-280 × 10-12μ, 8-spored, turning blue with iodine. Spores elliptical, 12-13 × 6-7μ, very minutely verrucose, biguttulate. Paraphyses straight or curved at the thickened apex, 280-290 × 4-5μ, filled with violet granules, septate.

Rubbish heaps, Glasgow, 21st July, 1916, Mr. D. A. Boyd.

It is very like *Aleuria violacea* (Pers.) Fr., but differs in the *rough spores.*

Cheilymenia cinnabarina (Schw.) *Lachnea cinnabarina* (Schw.) Massee & Crossl. Naturalist, 1906 (No. 588), 8.

Specimens, gathered by Mr. James Menzies on soil from cleaned-out ditches at Scone, Perthshire, on the 17th September, 1916, agree in all respects with the diagnosis given in the Naturalist. No description is given of the "few, slightly thick walled hairs" on the exterior of the cups. These hairs are mostly marginal, pale ochraceous, somewhat blunt, thick walled, and vary from 75 × 12μ, 120-150 × 9-10μ, septate, two or three hairs often arise from the same basal cell. From the character of these hairs and the thick lenticular disc it is clear that this species should be assigned to Boudier's genus *Cheilymenia*.

Scutularia citrina (Chev.) Sacc. Sacc. Syll., viii., No. 3317.

A fair number of specimens of this rare Discomycete were found by Mr. James Menzies growing on old pine cones near Perth on the 1st November, 1916. The disc is greenish and the immature asci are yellowish. Asci fusiformly clavate, attenuated into a narrow stalk, 120-150 × 10μ, no blue reaction to iodine. Spores hyaline, acicular, 60-80 × 1.5-2μ, multiguttulate, at length spuriously multiseptate. Paraphyses filiform, straight, somewhat blunt at the apex, 120-150 × 1.5μ.

LASIOBOLUS MACROTRICHUS Rea. Vide t. viii.

Ascomata minuta, ·5-1 mm. lata, sessilia, fulva, aut fulvo-aurantia, primo obconica, dein expansa, extus *pilis longissimis*, rigidis, rectis, acutis, continuis, ad basim incrassatis, parietibus 5μ spissis, 850-950 × 16-18μ, *albis* vestita, margine nudo, disco colore saturatiore. Asci cylindracei, basi sensim attenuati, 180-195 × 15-16μ, operculati, 8-spori, iodo haud tincti; sporae hyalinae, ellipticae, 20-22 × 9-10μ, leves. Paraphyses hyalinae, primo ascos excedentes, 185-200 × 4-5μ, simplices aut ramosae, ad apicem non incrassatae, septatae. Ad stercus *Cervi Elaphi* in sylvis prope Horner, Somerset. Legit Norman G. Hadden, 11.v.1916.

It differs from *Lasiobolus equinus* (Müll.) Karst. in the very long hairs on the exterior of the cup, the absence of a gelatinous envelope to the spores, and the hyaline paraphyses destitute of coloured oil granules. The hymenium varies from pale to fulvous when grown in the shade and becomes orange colour in direct light. Mr. J. Ramsbottom successfully cultivated it on agar-agar made up with a solution of horse dung to which bits of filter paper had been added, and it was found to retain all its distinguishing characters.

Leotia lilacea Bres.

Buckden, Naturalist (1917), 131.

RECENT PUBLISHED RESULTS ON THE CYTOLOGY OF FUNGUS REPRODUCTION (1916).

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During the past year comparatively few papers have been published on fungus cytology. It was only to be expected that a noticeable diminution would be apparent in the amount of work appearing after the time when the researches more or less completed before the outbreak of hostilities had been published. We cannot hope for much advance in any of the sciences of no immediate national service until some time after the period when neutral nations will no longer have their temporary monopoly of pure science.

It is known that one or two papers have appeared during the past two years which are not summarised in the present paper.

PHYCOMYCETES.

Moreau has a short note on the formation of spores in the sporangium of *Mucor Mucedo*. Previously working with *M. spinescens** he found that the peripheral portion of the protoplasm of the sporangium became arranged in cords which then contracted round the nuclei and finally broke up into uninucleate spores. In *M. Mucedo,* however, the spore-producing portion of the sporangial protoplasm contracts, and divides into irregular portions, each of which becomes a spore. The young sporangium is multinucleate, and the spores formed from it are also multinucleate from the beginning. This method of spore formation is similar to what occurs in *Sporodinia grandis* (Harper, 1899), *Phycomyces nitens, Rhizopus nigricans* (Swingle, 1903).† Moreau suggests that the presence of two such totally different types of spore formation in the same genus may enable a more natural arrangement of the numerous species than we have yet obtained by the study of external morphology.

* *Cf.* Trans. Brit. Mycol. Soc., IV., p. 261 (1914).
† Also Moreau, loc. cit.

DISCOMYCETES.

M. and Mme. F. Moreau (1916) have made some observations on the Discomycete, *Agyrium flavescens,* parasitic on the lichen *Peltigera polydactyla.* The fungus occurs on the lower surface of the thallus amongst the lowest hyphae of the medulla. Its hyphae are interwoven with those of the host, being narrow, septate, formed of short cells, each of which contains a single small nucleus, whereas the lichen hyphae of the lower medulla are of a much greater diameter, with much thicker walls and poorer contents. The mycelium of the fungus is intercellular and does not penetrate the lichen hyphae in any way. In places it elongates between the cells of the host; in others it masses in the intercellular spaces. The masses quite at the lower face of the medulla develop into more or less voluminous, compact balls, which eventually form perithecia, of the same globular form. These, at maturity, enclose asci with eight uninucleate spores. There is no distinct excipulum, but the cells of the superficial hyphae of the medulla, usually flattened and dead, form a sort of envelope round the perithecium, of which the external hyphae are sterile.

The filaments of the fungus are often devoured by *Amœba sphaeronucleolus.*

PYRENOMYCETES.

In the Pyrenomycetes, Vincens (1916) has a preliminary note on the structure and development of a species of *Melanospora,* one of the Hypocreaceae. The ascogonium is composed of a spherical cell on a short pedicel of two or three cells. It is multinucleate, as are most of the cells of the thallus, " où l'on observe quatre éléments nucléaires rarement groupés en un noyau unique." Before the ascogonium divides, the cells of the stalk put out short lateral branches which apply themselves to it and rapidly form an envelope consisting at first of a single layer of cells. Spiral filaments borne on neighbouring mycelial filaments surround the whole, forming a secondary envelope of several cellular layers. These filaments sometimes come in contact with the ascogonium before the first envelope is quite completed. " Je n'ai cependant jamais observé le moindre enrichissement nucléaire de l'ascogone aux dépens d'une cellule de l'une ou de l'autre assise enveloppante."

Frequently, isolated spiral filaments form on the mycelium, giving rise on their spirals to conidia of the *Spicaria* type, similar to those which form directly on the mycelium. When such spirals arise near to one another they often join together,

forming a tuberculiform mass resembling the young perithecia in outward appearance, but, of course, remaining sterile.

The ascogonium soon divides after the formation of the double envelope, and by successive divisions a mass of small cells is formed, which have dense contents and are uninucleate. During the formation of this tissue the cells of the inner envelope undergo many divisions and form around it a false parenchyma of multinucleate cells, which is especially developed above it. The inner layers of the second envelope being pressed from the inside by the growing internal mass, flatten their cells tangentially, but remain hyaline with thin walls, whereas the external layers undergo repeated divisions, slightly thicken their walls and become brown in colour. Thus the young perithecium consists of a disc or slightly eccentric dome-shaped mass, towards its base, of dense tissue formed of uninucleate cells arising from the ascogonium, surrounded by a pseudoparenchymatous tissue developed from the ascogonial stalk. Enveloping this pseudoparenchymatous tissue are two layers having their origin from vegetative filaments, an inner portion of two or three layers of hyaline cells and an outer portion of two or three layers of protective cells with slightly thickened and coloured walls.

" Plus tard on observe parfois, dans le tissue ascogène, deux cellules voisines dont la paroi commune se résorbe et dont les noyaux se fusionnent, mais, par suite de la compacité du tissu dont elles font partie, il m'est impossible de rien dire sur le degré de parenté de ces deux cellules; de plus, je ne saurais affirmer, d'après mes seules observations, que ces fusions constituent une amorce indispensable à la production des phénomènes qu' on observe ensuite dans le tissu ascogène." The cells of the ascogonial tissue sometimes transform directly into asci, but more often give rise to short, very condensed mycelial outgrowths with branches which are hardly distinguishable from each other, with their terminal cells almost always becoming asci. Some of these terminal cells, however, at times give rise to paraphyses which are composed of short chains of multinucleate cells with vacuolate contents. As the asci ripen new outgrowths are formed below them, so that the perithecium encloses asci at all stages of development. The asci during their growth absorb the two pseudoparenchymatous layers which immediately surround them. " Il existe donc dans le périthèce un tissu nourricier dont l'origine est double et dont les éléments d'origine différente restent continuellement distincts les uns des autres."

While these phenomena are taking place the envelope which is at first entirely closed, forms a button-like projection

at the pole opposite the ascogonium. The cells of this cone as it projects more and more appear to undergo pressure from the interior and, stretched by the growth of the cone, dissociate along its axis and thus is formed a narrow canal, which is lined with clavate hyaline hairs.

The nuclear phenomena were not studied in detail. The nuclear divisions leading to the formation of unicellular spores show frequently eight chromosomes; the spores contain "soit deux novaux, soit deux groupes de quatre chromosomes non fusionnés." The spores on germination form two germination tubes, each of which receives four chromosomes. According to Vincens, the fusion between two nuclei arising from neighbouring cells originally distinct, constitutes a fact not previously noted in the Ascomycetes: but similar fusions have been described in the Pyrenomycetes, *Pleospora herbarum* (Cavara and Mollica, 1907) and *Leptosphaeria Lemaneae* (Brierley, 1913).* He regards the fact that the asci rise from branches of the ascogenous hyphae as being comparable to the origin in Plectascinales. Moreau (1914),† working with *Peckiella lateritia*, pointed out the resemblance between the structure of the perithecium in that species and in *Eurotium* and *Penicillium*. (Moreau regarded the binucleate condition of the cells of the divided ascogonium to have been brought about by a nuclear division).

Vincens states, "Je montrerai prochainement que l'on retrouve cette structure [*i.e.*, ascus formation] souvent avec encore plus de netteté, chez un certain nombre de Pyrénomycètes appartenant à des familles tres différentes." As he regards the classification of the Pyrenomycetes as artificial, he thinks the point of interest. The Pyrenomycetes have always offered great systematic difficulties. It is not to be thought that we have got anything like a natural classification of them as yet, and it is probably from the histological structure of the perithecium that we shall get points of most significance. A line of development in Ascomycetes would appear to have proceeded from the most primitive forms, through genera like *Eurotium* to certain Hypocreaceae. It does not appear possible, having regard to all the facts at our disposal, to consider that any fungus group arose from the Florideae. The Lichens, a polyphyletic group, considered as a whole and having regard to their relationship to various fungus families give no support to the theory of a Floridean ancestry.

UREDINEÆ.

Kunkel (1916) contributes some further observations on the rusts attacking *Rubus* in the United States. In earlier

* *Cf.* Trans. Brit. Mycol. Soc., IV., p. 270 (1914).
† ,, ,, ,, V., p. 99 (1915).

contributions he had established the fact that certain *Caeoma* spores (*C. nitens**) germinate like teleutospores. Tranzschel (1893), Clinton (1893, 5), and Liro (1907), had previously shown that *C. interstitiale* (which is morphologically indistinguishable from *C. nitens* and up to the present time considered identical with it) was genetically connected with *Gymnoconia Peckiana* (*Puccinia Peckiana*). Fischer (1915) tested the germination of the aecidiospores of *Gymnoconia Peckiana*. He obtained long germ tubes having all the characteristics of ordinary aecidial germ tubes. A thinner tube somewhat resembling a long sterigma developed at the end of one of the germ tubes, and Fischer thinks this may have been the result of growth disturbances. He also obtained teleutospores by sowing the aecidiospores. Fischer suggested that the contradiction between Kunkel's results† and those of other workers was due to the fact that they were working with different fungi. This would entail the occurrence of two orange rusts on the blackberries of America, and Kunkel now brings forward the evidence of their presence.

Plants well infected with a *Caeoma* agreeing macroscopically with *C. nitens* were collected from two localities where *Puccinia Peckiana* was known to occur. Spermogonia were present in great abundance. Aecidiospores were dusted over the surface of tap water. " In twenty-four hours most of the spores had germinated. They produced long germ tubes having all the characteristics of aecidiospore germ tubes. No cross walls were to be found and no branches that might be taken for elongated sterigmata. The twenty-one cultures of germinating aecidiospores were carefully observed under the

* The fungus named *Caeoma nitens* by Burrill was obtained from a district in which both the species investigated in the paper reviewed occur. The commoner species in U.S.A. is the one in which the caeomaspores give rise on germination to promycelia : it has not yet been recorded from Europe though there are certain indications of its presence. Kunkel uses Burrill's name for this species : it is best named *C. nitens* Burr. emend Kunk. It certainly cannot be placed in any known genus and a new one must be diagnosed for its reception and it would be well if the old specific name be used as indeed it must be if the spores be regarded as corresponding to teleutospores. The new genus *Endophylloides* Olive and Whetzel (Amer. Journ , Bot. IV., p. 50 (1917)) has " peridium wanting, or at least inconspicuous," but the chains of spores adhere to form more or less extended, cylindrical columns which are waxy or horny when dry).

The other species has as its caeoma stage, *C. interstitiale* Schlecht. and its teleutospore stage is *Puccinia Peckiana* Howe. Lagerheim proposed the genus *Gymnoconia* for the reception of this species because of the lack of peridium or any kind of covering to the caeoma. He made the combination *Gymnoconia interstitiale* (Schlecht). As the specific name, by the International Rules, is to be taken from the teleutospore stage the name *Gymnoconia Peckiana* (Howe) Trotter should be used.

† *Cf.* Trans. Brit. Mycol. Soc., IV., p. 277 (1914); V., p. 106 (1915).

microscope, and in only one case must an exception be noted. One spore was found which had put forth a long germ tube that branched into two parts. On one of these branches two quite normal sporidia were borne on typically formed sterigmata. It is difficult to explain this case. Either the spores which gave the promycelium was a contamination or the aecidiospores of *Gymnoconia interstitialis* are in rare instances capable of functioning as teleutospores. The writer is inclined to the latter view." A second sowing was made of the spores for comparison with spores of *C. nitens* from another locality, each being dusted on tap water and on Beyerinck agar. All the cultures were made at the same time, and incubated at room temperature. A large percentage of the spores germinated; in the one case long non-septate typical aecidiospore germ tubes occurred and in the other promycelia in all cases.

A study of stained material of the aecidiospore germ tubes shows that they typically contain two nuclei which lie together near the end of the tube. Sometimes they are separated by a distance of two or three hundred microns, but they are never very far apart. "The close proximity of the nuclei suggests that these germ tubes would give rise to sporophytic mycelium." The bases of the tubes appear quite empty, while the protoplasm becomes more and more dense towards the apices. The nuclei are strikingly large, being often of almost as great a diameter as the tubes. In some cases they have the appearance of ordinary resting nuclei with a distinct nuclear membrane and chromatin strands: in others, however, it is difficult to make out a nuclear membrane and the strands are quite dense and stain so deeply that they are indistinct. "In no case have nucleoli been observed and nuclear figures seem to be absent from the preparations. One tube was found that had three nuclei, but this is a very rare case. The length of the germ tubes, the presence of only two nuclei, the large size of the nuclei, the absence of division figures and the lack of septa are all characteristics which show that these spores in their germination function as aecidiospores."

Rubus spp., from a region where *C. nitens* occurs, were inoculated with aecidiospores, and although most plants showed no sign of infection (a phenomenon encountered by both Liro and Fischer), one plant developed sori of *Puccinia Peckiana*. "Without a doubt, *Puccinia Peckiana* is the teleuto-stage of *Gymnoconia interstitialis*." Transplanted *Rubus* plants infected by the *Caeoma* afterwards developed teleutospores. Experiments also showed that *Rubus* plants inoculated with the spores of *C. nitens* produced the *Cacoma*

again, though the inoculation with teleutospores of *P. Peckiana* for some reason failed to give any result.

A comparison of the two caeomas "failed to disclose either macroscopic or microscopic morphological differences between the two rusts. So far as the writer has been able to observe, both are exactly alike morphologically. Only after having germinated the spores is it possible to distinguish between the two forms."

The question of the relation of the two species naturally arises. Although in the usual classification of Uredineae the two would be placed far apart, it can hardly be held that the extraordinary similarity of the caeomata could be brought about by homoplastic development. The isolated instance of an aecidiospore of *Gymnoconia* producing a promycelium is suggestive, but not much weight can be placed upon it for various obvious reasons, though such as it is it points to a fact that seems to be hinted at in not a few cases, viz.: that certain spores are capable of functioning in different ways according to conditions and that definite stages may be omitted from what are normally obligate cycles.

Arthur and Fromme (1915) after the publication of Kunkel's results on *Caeoma nitens* investigated *Aecidium tuberculatum* and showed that the spores produce promycelia on germination. Arthur had previously tested the germination in hanging drops in a van Tieghem cell and found only non-septate germ tubes. In the present case spores were sown on the surface of a non-nutrient agar—a method apparently first suggested by Kunkel. The spores on germination produced promycelia and sporidia in abundance. "The teliospores are normally one-celled, but occasionally two-celled spores are produced, and one or more of them may be found in any mount. Their wall thickness, colouring and verrucose sculpturing is like that of the one-celled spores, from which they differ only in form and the presence of a horizontal median septum. They are found in microtome sections of the sori scattered among the one-celled spores in the upper part of the spore chain. Each cell contains two nuclei, the products of the conjugate division of the two nuclei of the one-celled spores from which they arise by a vegetative development." The two-celled teleutospores suggest the genus *Pucciniosira,* but all other morphological characters are those of *Endophyllum,* to which genus the species is referred.

The germination stages of the spores of *E. tuberculatum* are similar to those described by Hoffman for *E. Sempervivi* and by Kunkel for *Caeoma Peckiana.* "The promycelium is divided, as a rule, into four uninucleate basidiospore initial

cells and a basal stalk." Each initial cell gives rise to a sporidium on a sterigma. Under suitable conditions the sporidium germinates at maturity.

"The production of basidiospores is dependent to a considerable degree on the exposure of the promycelium to a free air surface."* On a moderately hard agar the basidiospore initial cells produce germ tubes directly without the formation of basidiospores.

Bartholomew (1916) has made some observations on *Hyalopsora Polypodii*. Teleutospores were apparently first noticed in this species by Dietel (1899). There are two other spore forms present, one with a thin wall, the other thick-walled. These have been regarded as two forms of uredospores by most writers (Dietel, Fischer, Bubak, Hariot, Grove), but Arthur (1907) describes them "for convenience" as uredospores and aecidiospores respectively. Both kinds of spores have been recorded as occuring in the same sorus (Dietel). Arthur states that the sorus containing thin walled spores has a very delicate peridium but most other writers say the peridium is absent in all cases. There is also a confliction of statements as to whether the spores possess a stalk or not.

Bartholomew's results were obtained by a study of fresh material in field and greenhouse and by that of fixed and sectioned material. "In both field and greenhouse considerable difference was noted between the appearances of the sori produced in cloudy weather and those produced during a period of sunshine." During periods of cloudy weather lasting three or four days to a week or more the sori remained

* Many recent investigators have specially remarked upon this fact as if it were a new discovery, though it is difficult to understand how any one germinating teleutospores in a hanging drop should not be immediately cognisant of it. It is also well-known in the Ustilagineae. V. H. Blackman in 1903 in a paper on the conditions of teleutospore germination and of sporidia formation writes: "It is clear from the two sets of observations that, in the forms under consideration, the *submerged* germ tube or promycelium is incapable of sporidia formation, but that its growth in length is only limited by the reserve material at its command. Sporidia formation however takes place directly the tube reaches the air, and if this condition is present from the beginning of germination, growth in length is of very short duration and the promycelium becomes reduced to little or nothing more than the characteristic four cells. . . . . It is curious that this exact relation, apparently so easily ascertainable, should in the Uredineae require definitely stating; one can hardly believe that it has been overlooked by all the workers on teleutospore germination, but no suggestion of it could be found in botanical literature except the statement of de Bary (p. 281), 'The simple tubes which may develope from the [teleuto]spores of *Endophyllum* when they are placed under water do not become promycelia, and are, as far at least as we at present know, incapable of further development.' This would appear to show that de Bary recognized that in *Endophyllum* at least, air was necessary for the formation of sporidia, but it remains an isolated statement made in relation to the question of the stages of complexity of developments of the Uredineae."

pale grey, but within twenty-four hours after the sun appeared they assumed a bright orange colour. Sori formed during sunny weather took on a yellow colour even when quite small. It is not difficult to dissect an infected pinna in such a manner that large masses of the mycelium may be obtaned free from the host tissue. Bartholomew found that the spores have short stalks. "In studying stained sections of a very large number of sori which had not yet broken open, not one was found without a peridium. . . . . Ordinarily, though not always, by the time the sorus had become erumpent, the peridial cells have disintegrated to such an extent that they are scarcely noticeable. . . . . Perhaps the most interesting part of the results of this investigation concerned the nuclear condition of the hyphae. . . . . Without exception the cells of these hyphae were found to be binucleate. This was true of hyphae taken from the bases of sori in which the majority of the spores were thick-walled, as well as of those taken from the bases of sori containing mostly thin-walled spores. . . . . From these observations it would seem that there can no longer be any basis for calling the thick-walled spores aecidiospores and the thin-walled spores urediniospores." Bubak (1904-06) attempted to inoculate species of *Abies* and *Pinus* with *Hyalopsora* but was unsuccessful. Bartholomew thinks the two kinds of uredospores are primitive, regarding the rusts occurring on ferns to be the earliest forms. The paper, however, while giving much useful information, does not enter fully enough into certain questions to enable theoretical deductions of much worth to be drawn. A comparison of the cytological phenomena in the germinative spores might give some valuable hints; and a study of the teleutospores by modern methods will doubtless clear up certain questions. We hope Bartholomew will publish a much more detailed account of this interesting fungus.

BASIDIOMYCETES.

Juel (1916) has published an account of the basidia of species of *Cantharellus, Craterellus* and *Clavaria*. Wager (1893-4) investigated species of *Amanita, Stropharia* and *Mycena,* and showed that two successive mitoses occurred in the basidium, the nuclear spindles lying transversely in its upper portion. Poirault and Raciborski (1895) and Sappin-Trouffy (1896) first showed that the nuclear spindles in the promycelia of the Uredineae are longitudinally arranged. Juel (1898) investigated the protobasidia of *Coleosporium, Auricularia* and *Exidia,* and the eubasidia of *Dacryomyces* and *Muciporus (Tulasnella).* Transverse spindles were

found in *Exidia* and *Tulasnella* and longitudinal spindles in the other genera. As longitudinal spindles are usual in hyphal cells, no special theory is required to explain them. The transverse spindle in *Exidia* was thought by Juel easy of explanation, as it is usually in the direction of the walls of the protobasidium. Juel considered that the transverse spindle of Hymenomycetes must be explained as having arisen from the protobasidium of the Tremellineae type by the suppression of the longitudinal walls, the direction of the spindles remaining unchanged. The transverse spindles of Dacryomyces would similarly be derived from the *Auricularia* type of protobasidium. Juel divided Basidiomycetes into two series, Stichobasidiae (with longitudinal spindles) and Chiastobasidiae (with transverse spindles) and considered that in each series there was a development from protobasidia to autobasidia. No Gasteromycetes were studied. Since that time many Basidiomycetes have been studied, Maire (1902) being the principal investigator. Juel arranges these species in his two series. In the following list, where not otherwise indicated, Maire is the authority :— S indicates Stichobasidiae; C, Chiastobasidiae. CLAVARIEAE. —S. *Clavaria rugosa, C. grisea;* C. *Sparassis crispa.* THELEPHOREAE.—S. *Exobasidium Vaccinii, Peniophora quercina, Thelephora palmata, T. anthocephala, Craterellus cornucopioides;* C. *Tulasnella* (*Muciporus,* Juel), *Vuilleminia comedens, Corticium lacteum, Hypochnus Sambuci, H. subtilis* (Harper), *H. terrestris* (Kniep), *Cyphella digitalis, C. villosa, C. ampla.* HYDNEAE.—S. *Hydnum repandum;* C. *Radulum laetum, R. molare.* POLYPOREAE.— C. *Fistulina hepatica, Merulius lachrymans, Trogia crispa, Lenzites flaccida, Trametes suaveolens, Polyporus versicolor, P. acanthoides, Boletus regius, B. tessulatus, B. scaber, B. flavus, B. granulatus* (Levine). AGARICINAE.—S. *Cantharellus cinereus, C. tubaeformis, C. cibarius;* C. *Cantharellus (Dictyolus) bryophilus, C. (D.) glaucus, C. aurantiacus* (*Clitocybe*), *Hygrophorus virgineus, H. miniatus, H. conicus* (Maire, Fries), *H. ceraceus, H. agathosmus, H. lucorum, Gomphidius glutinosus, Lactarius deliciosus, L. piperatus, Paxillus involutus, Amanita pantherina, A. muscaria* (Wager), *A. bisporigera* (Lewis), *Lepiota lilacino-granulosa* (Ruhland), *Armillaria mellea* (Ruhland, Kniep), *Collybia tuberosa, Mycena galericulata* (Wager, Maire), *Clitopilus orcella, Pluteus cervinus, Pholiota lucifera, Naucoria nana* (Petri), *Psalliota campestris, Stropharia stercoraria* (Wager), *S. semiglobata, Hypholoma appendiculatum* (Ruhland, Maire), *H. fasciculare, Psathyrella disseminata, Coprinus porcellanus* (Ruhland). All Gasteromycetes investigated,

Scleroderma vulgare, Lycoperdon gemmatum, L. pyriforme, L. excipuliforme, Geaster fimbriatus, Hydnangium carneum (Bambecke); *Nidularia globosa, N. pisiformis* (Fries), and *Cyathus hirsutus* are Chiastobasideae. In his present studies Juel has investigated the basidia of *Cantharellus cibarius* and *C. umbonatus*. Maire (1902) mentions that the basidia in the former species are very similar to those of which he gave a detailed description in *C. cinereus;* the spindles are longitudinal and do not lie at the apex of the basidium; the number of sterigmata fluctuates, six-spored basidia being frequent; the second nuclear division in the basidium may be omitted altogether or one nucleus only may divide. If more nuclei than sterigmata are present two generations of spores may be formed.

Juel's results confirm most of these points. The young basidia are long and cylindrical and as they ripen gradually broaden upwards and raise their tips somewhat above the hymenium. They often bear six spores, occasionally five, seldom seven. The nucleus in most basidia is in the prophase which resembles a spireme. Probably in many there is a single interwoven chromatin thread, but very often a number of separate threads are present, but so arranged that it is impossible to count them. No parallel arrangements of these threads was observed. In what are probably later stages the threads lie somewhat more apart and number about eight. Figures similar to diakinesis were not seen. The nucleus draws itself together later and the further changes in the thread could not be followed. The chromosomes are never arranged in a distinct nuclear plate but occur irregularly on the spindle. Not more than four appear to be present and they pass undivided towards the pole.

The second division is apparently entered upon immediately. The two spindles lie at different levels. Two chromosomes pass to each pole. "Nach der zweiten Teilung tritt wahrscheinlich sofort eine dritte ein." The sterigmata are built at this stage and often already bear the spore-beginnings. The whole plasma together with the nuclei is gathered in the upper portion of the basidium. The eight nuclei are very small and are like small chromatin bodies in appearance. Only one nucleus passes into each spore and no nuclear division takes place there. The number of spores is seldom equal to the number of nuclei so one often finds the supernumerary nuclei or chromatin bodies in the upper portion of the basidium. The amount of protoplasm remaining in the basidium is in general so small that a second production of spores could hardly take place though whether it does so or not is very difficult to make out. "Ich kann

die Möglichkeit eines solchen Vorgangs nicht bestreiten, habe aber bis jetzt keine Fälle gefunden, die unzweideutig dafür zeugen." Maire considers that the chromatin threads change directly into "protochromosomes" of varying number before the formation of the first nuclear spindle. Juel thinks these are the bodies that he has observed and that their number is definite and probably eight. The number of chromosomes in the anaphase of this division as in the following is two. The end result of the reduction-divisions is therefore four nuclei each with two chromosomes. It can therefore be supposed that the chromosomes of the granddaughter nuclei are already prepared in the first prophase. "Die vier Chromosomen an der ersten Spindel durften aus je zwei der Prophasenfäden zusammengesetzt sein, und je zwei von ihnen dürften zusammen einem Doppelchromosom entsprechen. Da ich keine Kernplatten gefunden habe, kann ich nicht wissen, ob sie nicht in diesem Stadium zu Doppelchromosomen verbunden gewesen sind."

C. umbonatus shows a higher type than *C. cibarius* both in the structure of its gills and in its basidia. These latter regularly have four sterigmata and four spores and hardly project beyond the general hymenium. The nuclear spindles are transverse and spiral. Two nuclear divisions occur as a rule and in only one case was it thought that a third division occurred. A paired or parallel arrangement of nuclear threads was not usually distinctly seen. Four pairs appear to be present. The chromosomes on the spindle do not appear clear enough for their number to be ascertained. As a rule the grand-daughter nuclei become rod-shaped in creeping through the sterigmata into the spores. "In sehr vielen Fällen bildet der Kern in der spore eine Kernteilungsfigur." As in every spore observed there was only one nucleus present this nuclear division is probably not completed. Four species of *Craterellus* were investigated, *C. cornucopioides, C. lutescens, C. clavatus* and *C. pistillaris*.

Craterellus cornucopioides was examined rather rapidly by Maire : he records a four-spored basidium. Patouillard (1887) says the basidium is bi-spored and this is supported by Juel's observations.* Maire mentions that the basidia lengthen during the nuclear divisions, that two divisions occur in which the spindles are oblique, and that the spores are uninucleate. Juel believes that the hymenium renews itself gradually as he observed spores strewn over the surface and not in layers as Maire observed in *Thelephora anthocephala* (*cf.* also Buller on *Coprinus* spp.). The chromatin threads

* In British specimens which I have examined the basidia are usually bi-spored but not infrequently three spores occur on the basidia.

in the young, slender basidia lie mostly without order, but in some cases they were arranged in four pairs. The chromosomes lie irregularly on the first nuclear spindle and are probably four in number. The spindle of the second division shows a distinct nuclear plate stage: two chromosomes occur on the spindle. "Dass eine dritte Teilung immer ausgeführt wird, kann ich nicht behaupten, ich sah jedoch recht viele Basidien mit vier kleinen Kernspindeln." As the basidia are thin walled they collapse in preparations and the fate of the nuclei which remain over in the basidium could not therefore be followed. "Es scheint mir aber kaum wahrscheinlich, dass sie im Stande sein sollten, neue Sporen zu erzeugen."

C. lutescens shows clamp connections very frequently in the subhymenium and at the basal end of the basidia. In the majority of the young basidia the nuclei appear in synapsis or spireme-like phases. It later greatly contracts. In nuclear division the spindle is distant from the tip and more or less oblique. After a resting period a second division occurs with spindles at different levels. Basidia with four spores were not infrequently seen. The basidia have usually five sterigmata (sometimes three or four). The spores are uninucleate. "Eine dritte Kernteilung beobachtete ich einige Male," but whether it regularly occurred was not established.

C. clavatus shows a renewal of the hymenium. The basidia here become broadened at the tip into which the nucleus passes and divides with a transverse spindle. The form and the number of chromosomes are difficult to make out but the number is probably not more than four. Both daughter nuclei lie against the wall, exceptionally only one nucleus is seen. The spindles of the second division are also transverse: sometimes only one is present. The nuclei rest in the lower portion of the swelling. Three or four sterigmata grow out and the nuclei elongate and pass into the spores. The nucleus sometimes takes on a spindle shape in the spore but probably no division takes place as only uninucleate spores were seen. Exceptionally, however, a third division must take place as eight nuclei were seen in the basidium (and spores).

C. pistillaris is, according to Juel, probably only a variety of *Clavaria pistillaris*. The nuclear divisions are rather difficult to follow because of the presence of yellowish granules in the protoplasm. The young basidia are cylindrical and have a somewhat large, elongated prophase-nucleus centrally placed, which contains rather numerous distinct chromatin threads. These do not show a parallel arrangement and there are probably many more than eight. The nucleus passes

upwards and the basidium elongates and its tip enlarges though it projects little above the hymenium. The first nuclear spindle is transverse and lies rather near the apex of the basidium. It is broader than in the previous species and has a larger number both of chromosomes and of achromatic fibres. Not infrequently a rather strongly marked nuclear plate is formed. The chromosomes (which do not fuse) are at least six in number, probably eight. It could not be ascertained whether they split or passed to the poles without division. The daughter nuclei lie close to the walls. The nuclear spindles of the second division are of the usual form: the number of chromosomes could not be made out. In many cases a single nucleus appeared on the wall, or a single nuclear spindle of the type of the second division. It may be that in these cases the first division is not regular and all the chromosomes go to one pole; or the division may be normal but one of the nuclei disappears immediately. The first view is supported by the fact that no trace of a second nucleus can be seen; the second view in that the single nucleus and spindle are not noticeably larger than when two are present. The four nuclei usually move downwards a little and become larger. Four sterigmata are formed, and denser undifferentiated plasma strands can often be seen passing from the nuclei to the tips of the basidium. The nuclei then pass into the spores. The ripe spores contain one nucleus: no nuclear spindles were seen in them.

In many basidia a third nuclear division takes place though this was not observed. Often six, sometimes five or seven, nuclei were seen in heaps in shrunken or withered basidia.

Thirteen species of *Clavaria* were investigated. I. Ramaria, A. Leucosporae: *C. flava, C. muscoides, C. subtilis, C. epichnoa, C. cinerea, C. cristata.* B. Ochrosporae: *C. aurea, C. abietina, C. crispula.* II. Syncoryne: *C. fragilis.* III. Holocoryne: *C. pistillaris, C. ligula* and *C. falcata.*

C. flava seems microscopically very close to *C. aurea.* The nuclear spindles as in most *Clavaria* spp. are transverse and apical. The basidia are four-spored.

In *C. muscoides* the hymenium gradually rejuvenates. The basidia are small and very crowded and not suitable for detailed study. The young basidium is relatively broader than in *Craterellus pistillaris* and many *Clavaria* spp., and the nucleus is more spherical. While the latter is still in a spireme-like stage it passes to the upper part of the basidium, which elongates very little during the nuclear divisions. The first nuclear spindle is transverse and takes up an extreme apical position. After the second division, four sterigmata are formed. When the nuclei have entered the spores

they show the shape of a nuclear spindle. "Ob eine Teilung ausgeführt wird, konnte ich nicht feststellen; in der reifen Spore ist überhaupt kein Kern zu sehen." No third division takes place in the basidium.

C. subtilis is very similar to the last species in its hymenium and four-spored basidia. The spindles are transverse and lie almost as near the tip of the basidium. In the spores nuclear-spindle-like figures were often seen. The spores are uninucleate.

C. epichnoa is very near to *C. crispula* in its microscopic characters. The hymenium is not so dense as in the two previous species; the young basidia are not so straight and slender as in most other species. The nuclear spindles are transverse and lie in the upper portion of the basidium. The ripe basidia are little elongated and bear four spores. These are usually uninucleate, exceptionally binucleate.

The two remaining white spored species of the Ramaria section belong to the Stichobasideae (*C. rugosa* and *C. grisea* studied by Maire also belong to this group). The hymenium in the young portions of *C. cinerea* is a single, thin layer. In the older portions it becomes a rather thick, compact layer of tissue showing clearly a radial arrangement. Strewn spores show that the hymenium is gradually renewed. The basidia are bispored and when mature their scarcely broadened tips stand rather high above the remainder of the hymenium. The nucleus lies about the middle of the basidium and there divides. In the usual prophase stage it is poor in content and its chromatin threads do not appear very numerous—somewhat as in *Cantharellus cibarius*. The first nuclear spindle is small, scarcely half as large as that of *C. cibarius,* and the chromosomes are rather indistinct. The nuclei may then rest. The second division was not seen, but the resulting nuclei enter into a resting period. Immediately after the second division the two sterigmata are formed. The four nuclei again divide during spore formation. This third division, or the eight nuclei resulting from it, were so often seen that it appears to be the normal occurrence. Only one nucleus passes into each spore and almost immediately becomes flattened against the wall. "Obgleich nach der Sporenbildung die zurückgebliebenen Kerne gut erhalten scheinen, und auch Plasma in der Basidie noch vorhanden ist, konnte ich mich nicht davon überzeugen, dass eine wiederholte Sporenbildung stattfindet."

The microscopic structure of *C. cristata* is very similar to that of the last described species. The basidia are narrow and when mature, elongated and bi-spored. The nuclei are small and clear figures are difficult to obtain. The first nu-

clear spindle is very small and lies about the middle of the basidium. Two resting nuclei are formed. The nuclear spindles of the second division lie at different levels. It could not be ascertained whether a third division occurred or not.

C. aurea is very suitable for the study of nuclear figures. The young basidia are long and cylindrical and the nuclei lie near their tips. The chromatin threads are very distinct in the prophase and though usually without order an arrangement in about eight pairs can sometimes be clearly made out. The basidium elongates and widens at the apex. Both nuclear divisions have transverse spindles which lie near the tip of the basidium. The spindle of the first division is long and narrow: it is difficult to make out the form of the chromosomes. In the nuclear plate stage probably four double chromosomes are present. In the second division the spindle is rod-shaped, and the chromosomes lie heaped together as a narrow equatorial plate. The chromosomes were in some cases clearly seen and number at least three, probably four. Sometimes only one nucleus or a single spindle of the second division type were to be observed.

The four nuclei pass downwards. After the four sterigmata are formed the nuclei become narrower above and approach the sterigmata from which dense strands of protoplasm pass out to them. The nuclei are now rich in granular chromatin. Often at this stage the nuclei form about four masses of chromatin, and as basidia with such nuclei are often found collapsed together, no further development probably takes place. The spores are uninucleate.

C. abietina is rendered difficult to study by the fact that its basidia are densely filled with roundish, yellow granules. The young basidia are somewhat clavate, and the nucleus lies near the tip of the basidium, where the first division takes place, the spindle being transverse. The mature basidia are little elongated and are regularly four spored. *C. crispula* possesses a hymenium scarcely so dense as in the related forms and the mature four-spored basidia appear a little more elongated. The spores are uninucleate. Clear nuclear divisions were difficult to find. The first nuclear spindle is transverse and lies near the apex of the basidium.

C. fragilis in its microscopic structure resembles *C. muscoides* and *C. subtilis*. The four-spored basidia lie densely packed in the hymenium and elongate little at maturity. The nuclei are very small and difficult to investigate. The divisions occur near the apex of the basidium and the spindles are transverse. "Die in die Sporen eintretenden Kerne führen sogleich eine Teilung aus, und die Sporen dürften

daher 2 Kerne führen." In some cases nuclei were seen to form a nuclear spindle at the entrance to the sterigma or even while still in the basidium.

C. pistillaris appears in every way similar to *Craterellus pistillaris*. The third nuclear division appears to occur only exceptionally.

C. ligula is most like *C. abietina*, but does not possess the yellow granules characteristic of that species. The first division occurs in the upper broader portion of the basidium yet some distance from the top. During the anaphase three or four chromosomes occur at each pole. Sometimes at the second division only one nuclear spindle appears. No trace of a third division was observed nor of any nuclear division in the spore. The basidia have four sterigmata; the spores are uninucleate.

C. falcata differs from the two previous species as much in the structure of its basidia as in outward appearance. The basidia are quite small and, when young, somewhat clavate. When mature their upper portion is broadened and they project above the hymenium. They usually possess seven sterigmata and spores, but often six, seldom eight. In this they resemble *Cantharellus cibarius* more than the other *Clavaria* species which have either four or two sterigmata. The first nuclear spindle is long and narrow, and has a somewhat longitudinal position. The nuclear spindles of the second division lie at different levels but have the same direction. "Die dritte Teilung, die ja ohne Zweifel stattfinden muss, habe ich nicht gesehen." The spores are uninucleate.*

Maire's investigations had shown that the Autobasidiomycetes were not exclusively Chiastobasideae as Juel had thought (with the exception of Dacryomycetaceae). Maire divided the Autobasidiomycetes with homobasidia into Protohyméniés (Vuilleminiaceae) and Euhyméniés (Cantharellineae, Polyporineae, Agaricineae, Lycoperdineae). The Cantharellineae (Peniophoraceae, Clavariaceae, Phylacteriaceae, Cantharellaceae, Hydnaceae, Exobasidiaceae) are Stichobasideae, the remainder Chiastobasideae. The Cantharellineae are characterised by their longitudinal or oblique nuclear spindles, by the variation in the number of daughter nuclei, spores and sterigmata. Further points seem to be that the basidia do not appear to develop simultaneously, basidia of all ages being found in the same hymenium; the basidia are generally cylindrical and little different from or-

* Juel points out that the spores of his species are "länglich, glattwandig," whereas Quélet describes them as "ovoide, finement grenelée."

dinary hyphae; the basidia elongate during development so that when mature they project above the hymenium. Maire regards the Chiastobasidiae as being a branch of the Stichobasidiae, and that it is from the Cantharellineae that the Agaricaceae and Polyporaceae develop.

Juel's present studies have shown that in the Cantharellineae, Stichobasideae occur as well as Chiastobasidieae, and that in the species of *Clavaria* so far investigated they preponderate. The Stichobasidial type of basidium shows the nucleus situated near the middle; the first more or less longitudinal nuclear spindle lies in about the same position, the second division occurs at a different level also arranged somewhat longitudinally; a third division usually occurs and Juel considers this as normal, not atypical as Maire held. The sterigmata range from six to eight to only two. The basidia in the Chiastobasidiae become widened above (at least at maturity) into a club-shape, but generally little elongated; their nucleus lies above the middle and the transverse nuclear spindles lie near their apex. A third nuclear division is very infrequent, though the nucleus sometimes divides in the spore. No transition between the two types was found in *Clavaria;* a slightly inclined spindle Juel regards as of little importance, the chief point of difference is in the lower position of the nucleus in the Stichobasidium and in the different levels of the spindles of the second division. "Wenn man die cytologischen Merkmale ins Auge fasst, so scheinen die beiden Basidientypen von einander scharf getrennt zu sein."

The ancestral type from which the Stichobasideae have developed must have had three nuclear divisions in the basidium and eight sterigmata and spores. *Cantharellus cibarius* and *Clavaria falcata* with their high spore numbers probably resemble this type. In the remainder of the species studied reduction has taken place, ending in the bispored basidia of *Clavaria cinerea* and *C. cristata.* The ancestral type of the Chiastobasidiae must also have had three nuclear divisions, as this still occurs in some species, but usually it is suppressed or has become transferred to the spores. If one accepts Maire's view that the Chiastobasidiae represent a higher type evolved from the Stichobasideae, one must assume that the transition has taken place in each of the three genera *Cantharellus, Craterellus* and *Clavaria.* If on the other hand Juel's theory be accepted and we regard the two as originally distinct types, we have in the same genera three cases of convergence of morphological evolution (Cf. *Hydnum* and *Tremellodon*).

Juel points out that no matter which view be taken, the old

genera *Cantharellus, Craterellus* and *Clavaria* cannot be regarded as natural genera. Maire, for cytological reasons, placed *Cantharellus aurantiacus* in the genus *Clitocybe* and *C. bryophilus* and *C. glaucus* in Quélet's genus *Dictyolus; C. umbonatus* is also not a typical species of *Cantharellus* in its thin, crowded gills and the structure of its trama.§ Patouillard has formed the genus *Neurophyllum* for the reception of *Craterellus clavatus,* and Juel now shows that *C. pistillaris* is a species of *Clavaria.* Juel suggests the probability of the old genus *Clavaria* being divided into two genera—one Stichobasidiae, the other Chiastobasidiae. Much histological and cytological work remains yet to be done in the Basidiomycetes and there can be no doubt that it will be of immense use to pure systematists whenever any point can be related to morphology, as it so easily can be in the case of the shape of basidia, the number of sterigmata and spores, and the type of nuclear division.

HYPHOMYCETES.

Welsford (1916) has made an interesting contribution to the question of conjugate nuclei. During an investigation of the process of infection by *Botrytis cinerea* it was observed that "the nuclei in the multinucleate hyphae of this fungus, produced by the germinating conidia,* are very generally arranged in pairs. . . . . The paired condition of the nuclei is only found in well-nourished fast-growing filaments, and hence it seems to be correlated with rapid growth. The pairing can be explained by the fact that nuclear divisions follow one another so rapidly that the sister nuclei formed by one division have not time to move apart to any considerable distance before they start dividing again. . . . . The fact that an unpaired nucleus is rare in a well-nourished filament indicates that the sister nuclei divide simultaneously."

"A similar phenomenon has been found in the mycelium of *Sclerotinia Libertiana.*† The nuclei in well-nourished hyphae growing in the stem of *Vicia Faba* are arranged in pairs, whilst in starved hyphae the nuclei are unpaired." Much has been made of the presence of conjugate nuclei in ascogenous hyphae as indicating the pairing of male and female nuclei in the ascogonium. Welsford points out that if the phenomenon she describes is general for the Ascomycetes, "and there is some evidence of this," the presence of nuclear

§ Juel suggests its position might be in Patouillard's genus *Geopetalum.*

* The conidium is presumably uninucleate.

† It is probable that the conidial stage of *Sclerotinia* is always a species of *Monilia; Botrytis cinerea* therefore would have no connection with *S. Libertiana.*

pairs in the ascogenous hyphae would give us no clue to the sexual processes. "The paired condition of the nuclei may simply be the response to the physiological conditions usually found in such hyphae, that of high nutrition associated with rapid growth." This pairing of nuclei in rapidly growing filaments is suggested in many published drawings of germinating spores (Cf. Ramlow's (1914) drawings of spores of *Ascophanus carneus*). Vallory* (1911) also recorded nuclear pairs in the young actively-growing mycelium of *Chaetomium Kunzeanum* var. *chlorinum* formed by amitotic divisions. It would seem that the mere presence of nuclei in pairs can of itself signify nothing. It is the method by which this paired condition is brought about that is significant: the nuclei may be sister nuclei just divided, nuclei which are about to fuse, or nuclei which are dividing conjugately. Also the end stage of this paired condition would seem to be of significance, *i.e.*, whether the nuclei ultimately separate, whether they fuse immediately, or whether their descendants fuse. In a truly binucleate mycelium such as we find in most Uredineae and Basidiomycetes, there is no difficulty: it is only in caenocytic organs that there can be different interpretations of the phenomena. Paired nuclei have been recorded in many parts of Ascomycetes, *e.g.*, the conidial mycelium of *Hypomyces perniciosum* (Massee, 1905), the paraphyses of *Helvella crispa* (Carruthers (1911)),† the large storage cells of *Helvella elastica* (McCubbin (1910)). It does not seem that all these can be explained on the theory of high nutrition with rapid growth. Whatever may be the sexual phenomena in such a highly disputed species as *Pyronema confluens*, it does not seem at all improbable that amongst the Ascomycetes there may exist forms in which a binucleate condition is present practically throughout the life history (as in some Uredineae, Ustilagineae and Basidiomycetes). A well-nourished hypha is, in the present writer's opinion, the *normal* condition, and the facts put forth by Welsford are, therefore, of great value in calling attention to possible errors of interpretation of phenomena, upon which large theoretical conclusions might be based.

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JOHN WILLIAM ELLIS

(1857-1916).

By J. Ramsbottom.

Dr. J. W. Ellis died suddenly at Liverpool on August 20th, 1916, while serving as Lieut.-Colonel in the Western Command of the R.A.M.C. He was buried with full military honours, the firing party being formed by the Cheshires.

Dr. Ellis was born at Doncaster on Jan. 24th, 1857, but his parents moved to Liverpool the same year and except for the period 1889-1891 he resided in this city until his death. A naturalist as it were by instinct, he took an interest in natural history as a schoolboy, and "while scarcely in his 'teens' he had formed a collection of Liverpool imports, gathered chiefly during his wanderings around the Liverpool Docks, and displayed, with appropriate labels, on planks laid across packing cases in an attic."

It was at first intended that he should succeed his father as chemist, and to that end he served four year's apprenticeship, but he himself had other ideas. Fired no doubt by the wonders described by naturalists who had collected abroad, and living in a seaport such as Liverpool, he took up the study of medicine while still an apprentice, with the idea of travelling and indulging in natural history studies. He became a student at the Liverpool School of Medicine in 1876. It is somewhat difficult to follow his numerous naturalist activities. He seems to have first taken up the study of entomology, and he joined the Lancashire and Cheshire Entomological Society in 1877. He worked principally at Coleoptera, being especially interested in the coprophilous lamellicorn beetles, and had collected materials for a monograph of the Aphodiidae when he left Liverpool (1889) for a couple of years' stay in the Isle of Wight and the Potteries. He was for many years secretary of this society. Meanwhile he had joined the Liverpool Naturalists' Field Club in 1882, and soon became honorary secretary of this also, in which office he continued until 1889 when he was elected an honorary member and presented with an illuminated address.

The year previous to leaving Liverpool, Ellis was successful in winning the Queen's Jubilee Prize of the Royal Botanic Society, presented by the Duke of Teck for the best essay on "The vegetable substances introduced into the arts and manufactures, and as food, during the fifty years of the Queen's reign," and consisting of a gold medal and fifty guineas. Naturally there was keen competition and Ellis was justifiably proud of his achievement. The essay was printed by the Society and freely distributed.

On returning to Liverpool in 1891 he again entered natural history circles. He was elected president of the Liverpool Naturalists' Field Club in 1899 and again in 1910, the latter honour being noteworthy in that it was the jubilee year of the Club. Afterwards he became botanical referee and filled the post of honorary secretary again from 1902 to 1909 (part of the time jointly). In 1909 he joined the Liverpool Botanical Society, of which he became vice-president and a member of their South Lancashire Flora Committee. He was also one of the foundation members of the Liverpool Biological Society. He took an active part in the work of the Liverpool Marine Biological Station in their investigation of the marine fauna of Liverpool Bay, in the work at Puffin Island and finally at Port Erin, acting as recorder for Actinozoa.

Apart from pure nature study, Ellis was keenly interested in photography but with him much of the interest lay in the outlook photography gave to a wider conception of nature. The fact that he was president of the Photographic Association in 1897 and won the Royal Photographic Society's medal (1905)—*the* prize to which photographers aspire—is sufficient to show how he excelled in the art. He was also interested in ecclesiastical architecture and wrote both popular and scientific articles on mediaeval fonts, of which his collection of photographs must be unique.

It was in the year 1910 that Dr. Ellis joined the British Mycological Society. He immediately devoted his attention to Pyrenomycetes and Sphaeropsideae and he was rapidly making headway in these groups. He commenced a series of articles on *New British Fungi* in our Transactions for 1912, and these appeared annually. He also published an account of *The Fungi of the Wirral District* (1911-14). He regularly attended the forays of the Society and was mainly responsible for the records of the groups in which he was particularly interested.

Dr. Ellis held the long service medal of the Volunteers, and at the outbreak of war volunteered for service.

Concerning his character a writer in the *Lancashire Natur-*

alist says: "His death is a great loss to Lancashire; the county can ill spare such a man. By the Liverpool Naturalists' Field Club will his loss be felt as a severe blow. As botanical referee, as honorary secretary, he was all-in-all to the Society. His whole purpose lay in its success and he had a wonderful way of covering small details which made the Society very dependent upon his services. . . . . Gentle and courteous at all times, self-sacrificing, and an ardent believer in that good-fellowship which we consider to be one of the finest possessions of a true naturalist."

From the facts related above it is seen that Dr. Ellis was a man of exceptionally wide interests, and when in the field with him one soon realised the vast fund of knowledge he had assimilated. He had a healthy abhorrence of sham and was of strong convictions. What impressed us all was his continuous courtesy, his unobtrusiveness and his keenness.

His collection of fungi has been purchased by Kew. The Liverpool Naturalists' Field Club has acquired his cabinet of Coleoptera and his herbarium. These have been presented to the city and are to be placed in the Museum. They are to be known as the Ellis Collection, and will be available for the use of all students and serve at the same time as a permanent memorial to one who was a naturalist, a patriot and a gentleman.

Most of the facts of this notice are taken from the *Lancashire Naturalist.*

(Dr. Ellis appears in the two groups which are reproduced in Vol. IV. of the Transactions).

JOHN WILLIAM HART

(1887-1916).

By J. Ramsbottom.

John William Hart was born at Wandsworth Common, S.W., on April 28th, 1887, and was killed on the Western Front on Sept. 15th, 1916. He was educated at private schools and after trying his hand at wheat-farming in

Canada and poultry and vegetables on a small holding in Wiltshire, he went to University College, Reading, as a student in Horticulture, paying special attention to Plant Pathology. He there obtained his Diploma in Horticulture. He was appointed head of the Botanical Garden of Bedford College for Women, and studied botany at Birkbeck College in the evening. He had practically completed his honours course when war broke out and he was later granted a B.Sc. (war degree). I knew Hart well whilst he was a student at Birkbeck College. He was hard-working and very capable, and with his practical knowledge of horticulture, it is certain that he would have advanced far in the scientific branches of that study which are beginning to be developed. We had many talks about possible developments in economic botany and Hart had certain clear notions: he was unostentatiously determined to be qualified in every possible way to play a proper part. Though working hard for his degree he still found time to investigate any fungus diseases he came across. He became a member of our Society and was engaged on some short papers for the Transactions dealing with the diagnoses of certain diseases of fruit trees during the summer of 1914. He volunteered for service immediately in the Civil Service Rifles and went to France as a private in the 1/15th Battalion, London Regiment, in March, 1915. Latterly he was Lance-Corporal and had been nominated for a commission. He was, however, killed in the attack on High Wood in the Somme battle on Sept. 15th, the day on which the tanks were first sent forward. Being himself wounded he crawled over to help a more seriously wounded comrade when the enemy turned a machine gun on him and murdered him. The action of the German machine gunners seems typical—the manner of Hart's death was certainly so: one can most easily imagine him meeting his end while tending to some helpless comrade.

There was certainly no attraction in the business to him. He had sufficient imagination to realise all the horrors of such warfare, and in his letters he was quite candid about the way shells and such-like startled him; but he had too strong a conscience to hesitate in taking his part in a conflict where he was on the side of right, no matter what the cost. Truly one of the greatest wonders of this omnipresent war is the manner in which our men of quiet demeanour, haters of strife of all description, stepped forward from congenial occupations and surroundings to take a part, of their own free will, in what they have regarded as a crusade against military oppression.

Hart was a true naturalist—he sent home botanical and

geological specimens even from the first line of trenches—and would certainly have rapidly attained a prominent place amongst the younger mycologists. Our science can ill spare men of his character and capabilities.

I am indebted to his father, Mr. E. W. Hart, for certain facts.

CHARLES CROSSLAND

(1844-1916).

By J. Ramsbottom.

Charles Crossland, the well-known Halifax naturalist, died in his native town on December 9th, 1916. He was born on September 3rd, 1844, his parents keeping a provision and general store in Halifax; he left school at the age of thirteen to help in the business. At the age of sixteen he commenced to learn the trade of a butcher, and when twenty opened a meat, grocery and general store at Wyke, where he remained until 1873 when he returned to Halifax having purchased a butchery trade there.

About 1880 he began to take an interest in place names particularly those within the ancient parish of Halifax. He found that more than a hundred surnames owed their origin to Halifax place names, which led to the tracing of the origin and significance of English surnames, 45,000 of which he collected and arranged in their respective classes.

In 1884 one of his daughters was making a collection of wild flowers for an exhibit competition in connection with a Sunday school. Without any previous knowledge of botany Crossland assisted his daughter. He had a pocket lens, presented to him by a friend, and by the aid of this he was able to enter a little more minutely into their structure. The plants were mounted and arranged, and his appetite being whetted the collecting was continued. This brought him into touch with the Halifax Scientific Society which he joined. Certain of the members settled down to a technical study of British wild plants by the aid of Hooker's *Students' Flora;* soon they added morphology and physiology, and

purchased the latest text books on the subject. They entered for the South Kensington examinations and eventually succeeded in passing the advanced stages in botany. A formal natural history section of the society was formed which devoted itself principally to the study of the local flora with Crossland as secretary.

He attended the fungus foray of the Yorkshire Naturalists' Union at Leeds in 1888 and here G. Massee persuaded him that he would find ample scope in mycology for any work he cared to do. Crossland set to work with a will and although at first he studied cryptogams generally he later restricted himself more and more to fungi. His first paper on fungi appeared in 1890—*Fungi new to W. Yorks.* The cryptogamic portion of the *Flora of Halifax* (1896-1904)* is from his pen.

The Yorkshire Naturalists' Union started a mycological committee in 1892 with Crossland as secretary. From 1893 to 1914 he wrote the accounts of the annual forays. Many new species were described by him chiefly in collaboration with Massee, and the two compiled the *Fungus Flora* of Yorkshire (1902-1905). Crossland, in consequence of the inadequacy of dried specimens of fungi, commenced to learn drawing and painting. His paintings, 550 in number (which were purchased by Kew in 1914), are excellent examples of careful work and scientific accuracy and are accompanied by detailed descriptions.

The British Mycological Society was founded at the fungus foray of the Yorkshire Naturalists' Union at Selby in 1896, and Crossland was elected treasurer.† The following year, at his suggestion, the posts of secretary and treasurer were combined in order to save unnecessary expense, and Mr. Carleton Rea took over the position which he has filled so ably up to the present time. Crossland continued a member of our Society until 1914 when he ceased mycological work. Two papers by him appeared in the Transactions, one in 1899 *On Mollisia cinerea and its varieties,* and the other in 1908 on *Omitted asci measurements of some British Discomycetes.* In February, 1914, he had an attack of paralysis which, however, partly passed away in five or six weeks, but left him subject to occasional attacks of giddiness. He took an active interest in Yorkshire mycology until October, 1914: he was presented with a silver salver at the Mulgrave foray as a token of his twenty-one

* " By issuing it as a separately paged supplement to the *Halifax Naturalist* of which it was the *raison d'être,* the financial difficulty was solved." Preface.

† He appears in the photograph in Trans. Brit. Mycol. Soc., IV., opp. p. 182 (1915).

year's service as secretary to the mycological committee. He then carefully prepared for the end and portioned out his collections to various friends and institutions.

Crossland was a man of many activities and one of the leading citizens of a go-ahead town. He was treasurer of the Halifax Butchers' Association from 1881 to 1908. He retired from his trade—he always called himself a "Knight of the Cleaver"—in 1914, though having taken a managing partner in 1890 he had afterwards a little more leisure, or, as he termed it, became a "half-timer." He spoke the Yorkshire dialect perfectly and was one of the founders, and later the President of, the Yorkshire Dialect Society. He was President of the Yorkshire Naturalists' Union in 1907, and gave as his address *The Study of Fungi in Yorkshire,* paying special attention to the work of James Bolton. This portion he afterwards amplified and published as *James Bolton, an 18th Century Halifax Naturalist.* After he had attained the age of sixty he undertook to prepare a Bibliography of Halifax—a work which appeared in instalments, published by the Halifax Antiquarian Society. He was engaged upon this until the week in which he died having practically completed it.

Crossland was one of the finest of the justly-celebrated north country working men naturalists. Commencing the study of fungi when approaching the age of fifty he made for himself a reputation for reliable work which spread very far beyond the boundaries of the county in which he was proud to have been born. He was careful almost to a fault. Mr. Sheppard, writing in the *Naturalist,** says: "When the Fungus Flora of Yorkshire . . . . was ready for the printers Crossland found that it would save the printers trouble, save the Union expense, and enable him to better judge the cost, if his manuscript were re-written; and, though his original manuscript was remarkably clear and distinct, he re-wrote the whole, giving not only the correct number of words, but the correct number of ems to a line and the correct number of lines to a page, so that the book eventually appeared word for word, space for space, line for line and page for page, as it was in manuscript." An admirer of his was so struck with the work that he bound the original manuscript and presented it to the Soppitt Library, Huddersfield. He had all the characteristics of what his county men would call a typical Yorkshireman. He was ever ready to give assistance, and no trouble was too great for him if he considered it worth the taking. His greatest desire was to

* *Naturalist,* 1914, p. 25.

interest others in those subjects in which he himself excelled, and having roped them in he was ever ready to help and inspire them to put their whole energy into the work. He was an amateur in the finest sense of the word and a man of sterling character.

I am indebted to Miss Agnes Crossland for most of the material from which this note is drawn up.

GEORGE EDWARD MASSEE

(1850-1917).

By J. Ramsbottom.

George Edward Massee, the first President of the British Mycological Society, died at Sevenoaks on February 16th, 1917, succumbing to an attack of influenza, and was buried at Richmond, Surrey. Born at Scampston, a hamlet in East Yorkshire, on December 20th, 1850, he was educated at a private school. It was intended that he should become a farmer as was his father, but, according to his own statement, he did very little good at farming. While working on the farm he became interested in wild flowers and in the larger fungi and drew and painted them. He was sent to the York School of Art, where he gained the national medal for the drawing of flowers from nature. His first publication was on *British Woodpeckers* which appeared in the *Intellectual Observer* for 1867. This paper of five pages and a coloured plate was remarkably good for a youth of sixteen. His mother's cousin was Dr. Richard Spruce, the botanist and traveller, and he encouraged him in his botanical studies. Later Massee went into residence at Downing College, Cambridge, but did not stay the necessary time to take a degree. Whether he continued his natural history studies there is not known. Cambridge had not, at that time, awakened from her deplorable sloth towards natural science. Spruce was able to give him the opportunity of going to the West Indies and South America for the purpose of orchid hunting and botanizing generally. He crossed to America on a French boat, traversed the isthmus of Panama, and then sailed along

the coast to Quito where he struck inland and made his way up the Napo. His only white companion was a Dr. Brown, picked up by chance on the way: the others were Indians hired from the Roman Catholic missionaries, who seemed to have extraordinary power over the inhabitants of the scattered villages. On their journeyings they collected orchids, fungi and ferns. On one occasion Massee was ill with dysentery for three weeks in an Indian hut unconscious some of the time and nursed by an old squaw. Hundreds of miles of mule-riding gave him a somewhat philosophical idea of a mule's characteristics, and in later years the sight of one of these animals called up reminiscences of perilous paths and a wise, cautious animal sometimes moved to indiscretions by the persuasion of a wisp of lighted straw attached to its tail. Massee had a painting which he himself had executed, depicting him on mule-back followed by an Indian leading another mule, with a few red-flowered cacti and a wide expanse of desert behind stretching to the distant Andes. While in the forest he lived on rice meal and an occasional monkey which cured him of all enthusiasm concerning the "simple life" which he regarded as being quite unobjectionable except when one is hunting for one's breakfast at supper time. The Indians persuaded him to go barefoot and he was afterwards very reluctant to return to his boots. One of his remarks about the Indians was that they were so lazy that they would spend an hour catching one of their half-wild horses in order to ride a few yards. Amongst his experiences in South America were earthquakes and a narrow escape from a puma which sprang down from the overhanging branch of a tree. He sent home in bulk *Oncidium macranthum* and *Nanodes Medusae*.

Returning home on a French boat, he and a few young Frenchmen joined the Foreign Legion as the Franco-Prussian War was then in progress. He transferred to the 4th Chasseurs—he had the name of this regiment tatooed on his left arm—but saw little or no fighting as the big engagements of the short war were then over. His mother, being alarmed, got into touch with the authorities and had him sent home, where she prevailed upon him to remain on the farm with his father: he was an only son.

While working on the farm he continued his botanical studies, specializing on fungi and plant diseases. When some years afterwards his father died, he and his mother moved to Scarborough where he taught botany in various schools and studied geology. About this time he nearly fixed on geology as a career for after working hard and passing an examination he was offered a post from which

he withdrew at the last moment. About this time he painted a large number of Agarics and his work attracted the attention of M. C. Cooke, who afterwards used many of the paintings for his *Illustrations*.* Massee collected assiduously in the neighbourhood of Scarborough, and this district remains one of the best worked in a county which has been explored, from a mycological standpoint, more thoroughly than any other. His first paper on fungi appeared in *Science Gossip*, 1880, and had the title *Notes on some smaller fungi*, including Myxomycetes. In the early eighties† he and his mother removed to London and eventually to Kew. He now began to do a certain amount of popular lecturing on such subjects as *The probable origin and spread of life, The dawn of life, The teachings of biology, New discoveries in the motion and variations of plants, etc.* He was appointed lecturer on botany to the London Society for the extension of university teaching and published some of his lectures in 1891 with the title *Evolution of Plant Life*. This dealt mainly with the evolution of cryptogams and showed a certain amount of originality though it suffered from uneven treatment.

At this time he was working as a free-lance in the Kew Herbarium, and published in 1891 a work on Phycomycetes and Ustilagineae with the ambitious title, *British Fungi*—"it is hoped that other volumes dealing with the remainder of the fungi will not be long delayed." This work, though much praised by mycologists at the time, is, even for its period, rather a failure. The following year appeared a *Monograph of the Myxogastres* which was completely overshadowed and outclassed by the Lister monograph which appeared two years later. In 1892 appeared also the first volume of *British Fungus Flora* (1892-95), a work in four volumes. Unfortunately a rather bizarre arrangement was adopted which made the portion on Basidiomycetes (more than half the work) rather difficult to use. This work was intended to have been a complete fungus flora but owing partly to the amount of space wasted, only the Basidiomycetes, Discomycetes and Hyphomycetes were treated.

During the years 1892-93 Massee worked at the British Museum being principally engaged upon the preparation of the exhibition stands of micro-fungi in the public gallery, a work which was completed and almost wholly done by Miss Lorrain Smith. Whilst working in the Botanical Depart-

* Massee's valuable series of paintings were acquired by the British Museum in 1892.

† He drew most of the plates in Spruce's *Hepaticae of the Amazon* (1885).

ment he and Batters decided to acquire *Grevillea,* Cook's quarterly cryptogamic periodical which he had edited for twenty years and which he now wished to dispose of. Massee acted as editor for the two volumes (XXI.-II., 1892-4), after which the publication ceased although Massee always held that such a periodical could be made a paying concern even at the present time. Cooke retired from Kew in 1893 and Massee was then appointed Principal Assistant in Cryptogams. Numerous papers had appeared from his pen during the previous few years. He settled down to his pathological work at Kew; in fact he created the study there. His knowledge of practical farming stood him in good stead and saved him from many errors liable to be made by those who do not understand agricultural principles. His *Text Book of Plant Diseases* appeared in 1899 and passed through three editions, being superseded in 1910 by the more ambitious though hardly more satisfactory *Diseases of Cultivated Plants and Trees.* In 1902 appeared the useful *European Fungus Flora: Agaricaceae.* The *Fungus Flora of Yorkshire,* written in collaboration with C. Crossland, appeared from 1902 to 1905. In 1906 a *Text Book of Fungi* was published. This shows a big advance on previous British text books, but lacks many of the points required in an elementary introduction. The cheap and useful *British Fungi and Lichens* appeared in 1911 with coloured plates by Ivy Massee: the title is misleading, as lichens are barely mentioned. His last book, written in collaboration with his daughter, *Mildews, Rusts and Smuts,* was published in 1913. It did not add to his reputation.

Massee had a world-wide reputation as a mycologist and when our Society was founded in 1896* he was elected president, a post which he held for a second year. He then resigned. During the years he had studied the various groups he acquired a knowledge of fungi which was practically unrivalled. But though often brilliant he was often careless: if he had had any capacity whatever for taking pains he would have been a genius. He had a clear mind and was regardless of authority; though he often totally disregarded results which would have prevented him reaching some rather startling conclusions. It was perhaps the result of his manner of training and of his period. He commenced when Berkeley was *facile princeps* in British mycology; Cooke followed and then Massee naturally forged ahead on Cooke's retirement. But times were changing and though Massee's opinions in systematic questions received the consideration

* He appears in the photograph in Vol. IV., facing p. 182 (1915).

due to his extended knowledge, when he attempted to criticize —or even ridicule—branches of the subject in which he had obviously no practical experience he did not add to his reputation. His cynicism often led him to say, and even to do, things which were much resented. His experiences with some of the younger school who called themselves mycologists and yet professed to despise "species" probably had much to do with a sharpness of tongue which seemed, on the whole, quite harmless when it did not run off the lines. I, personally, always found Massee very kind and jovial, and on one occasion he strongly advised a certain line of action where he thought the alternative would cause pain. He was well liked by the gardeners at Kew to whom he lectured on plant pathology. His knowledge of the practical side of their craft, his wide interests, his unorthodox manner, and his virility even to the end impressed them to an extraordinary degree.

For many years he was the recognised leader of the fungus forays around London, and knew the flora of Epping and Kew Gardens (of which he compiled the list of fungi) remarkably well. He was the Chairman of the Mycological Committee of the Yorkshire Naturalists' Union, which was founded in 1892 mainly as a result of his enthusiasm and energy. He was President of the Quekett Society in 1902, and was one of the original recipients of the Victoria Medal of Horticulture of the Royal Horticultural Society. Resigning from the Linnean Society in 1915 he was elected an Associate the following year. He was honorary member of many natural history societies. Having reached the age limit (extension) he retired from Kew in 1915 and removed to Sevenoaks.

Massee ranks with Berkeley and Cooke as one of the foremost mycologists of this country. He published over two hundred and fifty original papers.

I wish to thank Miss Ivy Massee for supplying me with certain information.

NOTES ON BRITISH THELEPHORACEAE.

By E. M. Wakefield, F.L.S.

The present contribution adds to the British list eight species of Thelephoraceae, two of which have not been previously described. It is evident that with regard to this group there is yet much to be learnt. The following notes deal with these new records, the species in question being marked with an asterisk. Some questions of nomenclature, which have arisen in connection with the study of the Thelephoraceae are also discussed.

The colour terms used are from Ridgway's "Color Standards and Color nomenclature," 1912.

Thelephora spiculosa, Fr.

This fungus is not uncommon in Britain, and has been previously recorded under the name *Thelephora mollissima,* Pers. It is somewhat variable, but among British species is readily recognised by its habit. It grows on the ground, spreading over dead leaves with fan-like clusters of slender branches, or encrusting the bases of grasses and other small plants in the same way as *Sebacina incrustans* Tul. The numerous slender cylindrical branches into which the margin of the sporophore divides have conspicuous whitish fringed tips, from which character the specific name is derived.

While the plant itself is fairly readily recognised in the field, there have existed, and still exist, differences of opinion as to its correct designation. It is identical with *Thelephora spiculosa* Fr. as understood by Bresadola, who examined authentic specimens. Owing to the inadequacy of the old descriptions there has been much confusion in the past with regard to the identity of certain species of Thelephora, and especially of those placed in the section "Merisma." On looking up the history of the present species, the names which come into consideration are *Merisma cristatum* Pers., *M. cristatum, β fuscum* A. & S. (=*T. spiculosa* Fr.), *M. penicillatum* Pers. and *Thelephora mollissima* Pers. As is now well known, the type of *M. cristatum* is a Sebacina, and may therefore be neglected in considering the identity of our Thelephora. The further history of the other names men-

tioned shows the greatest confusion. Persoon himself stated that he could not be certain as to whether his *T. mollissima* was a good species.

With regard to *M. penicillatum,* in the Hymenomycetes Europaei Fries followed Persoon's later opinion and referred it to *cristatum,* while stating that the plant which he had previously identified as *penicillatum* was the same as his *spiculosa.*

In 1908 von Höhnel published his opinion that *T. penicillata, T. spiculosa, T. mollissima,* and also *T. crustacea,* Schum. all refer to one and the same species, and adopted for it the name *T. penicillata* (Pers.) Fr. as being the earliest specific name. Quite probably he is right as to this synonymy, but the name *T. spiculosa,* Fr. is to be preferred for two reasons. *T. spiculosa* is known from authentic specimens, which have been examined by Prof. E. A. Burt and by the Abbé G. Bresadola.* On the other hand, the types of Persoon's *mollissima* and *penicillata* apparently do not exist, and from the descriptions alone it is impossible to reach any finality with regard to these species. It is therefore better to discard these names unless it can be proved that there are species distinct from the one under consideration, which might be referred to them.

Granting that the three names are synonymous, however, the adoption of the name *T. spiculosa* is still justified according to the International Rules of Botanical Nomenclature. According to these rules the starting point for the nomenclature of the Basidiomycetes is Fries' Systema Mycologicum, 1821. In this work there occur the names *Thelephora spiculosa* Fr., *Thelephora penicillata* (Pers.) Fr., and *Thelephora mollissima* Pers. The *first* name mentioned is *T. spiculosa,* which is therefore to be preferred.

Recently Lloyd has expressed the opinion that there may be four or five species of Thelephora in this section, for which he suggests the specific names *biennis* Fr. (?), *spiculosa* Fr., *crustosa* Schum., *mollissima* Pers., and *fimbriata* (Schw.) Fr. *T. fimbriata* is an American species which may possibly be distinct, but in practice it appears to be impossible to distinguish more than one species among the European forms.

The following British specimens have been examined:— Kilmarnock, N.B., R. B. Johnson, 1910; Southampton, J. F. Rayner, 1910; Dromahaire, Co. Leitrim, Ireland, R. L. Praeger, 1916; Gower Peninsula, E. M. W., 1915; Wyre Forest E. M. W., 1916; Haslemere, E. M. W., 1913.

* Burt states in his monograph that an authentic specimen of *T. spiculosa* from Fries exists in the Kew Herbarium. I have been unable to find this specimen.

THE GENUS HYPOCHNUS.

It is the unanimous opinion of systematists who have worked with Thelephoraceae that the genus *Hypochnus,* in the sense originally proposed by Fries (Obs. Myc. ii., p. 278, 1818), cannot be maintained. The mere looseness of the tissue does not constitute a clear generic distinction from *Corticium,* all intermediate stages being found. Thus hyaline-spored species such as *H. Solani* are now referred to *Corticium.*

In 1881 Karsten (Rev. Myc. p. 23) emended the definition of *Hypochnus,* and confined the name to those species (the majority of those placed in the genus by Fries) which have coloured, warted spores. Unfortunately, however, this emendation was not adopted by Saccardo and by Engler and Prantl; *Hypochnus* in Saccardo is the Friesian genus; in Engler and Prantl it is used for the hyaline-spored species only, hence is a synonym of *Corticium.* In consequence, the name is still used in the Friesian sense in most works on plant pathology. On account of this confusion, I have hitherto preferred to ignore *Hypochnus,* and to use for the genus covered by Karsten's emendation the name *Tomentella,* which was only defined by Patouillard in 1887 (Hymenomyc. d'Eur.), although it was first used as a subgenus, without definition, by Persoon (Obs. ii., 1799, p. 18). I still think that in the interests of clearness the adoption of a known and universally understood name like *Tomentella* would have been preferable, although in the absence as yet of a list of "Nomina generum conservanda" such action is contrary to the International Rules of Nomenclature as applied to the Fungi.

There has recently appeared, however, the section of Professor Burt's monograph, *The Thelephoraceae of North America,* dealing with this genus, and he has decided, on grounds of priority, to adopt Karsten's emendation of *Hypochnus,* and not *Tomentella.* His work is the most important which has yet appeared in connection with this group, and having regard to this and to the fact that the name *Hypochnus is* really the "legal" one, it would be well for other workers to follow suit. In future therefore the British species hitherto referred to *Tomentella* will be placed in the genus *Hypochnus* Fr. emend. Karst. The five following species are new to Britain, and three of them were collected during the Society's autumn foray at Lyndhurst. The fourth differs from most species of the genus in colour, but agrees in the aculeate spore, and differs therein from *Hypochnella.*

**Hypochnus zygodesmoides* (Ell.) Burt in Ann. Missouri Bot. Gard., iii., 1916, p. 236. *Thelephora zygodesmoides* Ell. North Amer. Fungi (Exsicc.), 715, 1882.

Broadly effused, soft, with a floccose subiculum, easily separable. Hymenium loose, pinkish to vinaceous-buff, often with rusty stains. Subiculum and margin "Sayal" to "snuff-brown," loose and cobweb-like. Basidia cylindric-clavate, 40 × 6-8μ; sterigmata 4, 4-7μ long. Spores elliptical to subglobose, with fairly long, blunt spines, pale-coloured in the mass, but very pale straw-coloured to almost hyaline by transmitted light; spore-body 5.5-7 × 4.5-6μ. Basal hyphae pale brown, little branched and not frequently septate, without clamp-connections, 4-6μ in diameter.

Hab. On rotten bark, Lyndhurst, Hants., Sept. 28, 1916.

The species approaches in its pale spores such Corticia as *C. echinosporum;* in general habit, and in the brown basal hyphae, however, it is a *Hypochnus.* Burt regards *C. echinosporum* also as a *Hypochnus.* It is an intermediate species, but my reasons for retaining it in *Corticium* were explained when it was first recorded as British (Trans. Brit. Myc. Soc., 1914, p. 129).

**Hypochnus cinerascens* Karst. in Medd. Soc. pro Faun. et Flora Fenn., xvi., 1888, p.2.

Indefinitely effused, very thin and adherent, uniformly drab-grey to pale drab. Hymenium loose when seen under the lens. Basidia hyaline, cylindric-clavate, with 2-4 sterigmata, 40 × 6μ. Spores grey-brown, angularly sub-globose, with minute spines, 6-7 × 5-6μ, average 6 × 5μ. Sub-hymenial and basal hyphae much branched and frequently septate, with clamp-connections, 3-4.5μ in diameter.

Hab. On bark, Lyndhurst, Hants., Sept. 26, 1916.

Distinguished from *H. fuscus* by the grey colour, smaller spores, and thinner hyaline hyphae.

**Hypochnus botryoides* (Schw.) Burt in Ann. Missouri Bot. Gard. iii., 1916, p. 226. *Thelephora botryoides* Schw. Naturforsch. Gesellsch. Leipzig, Schrift, 1, 1822, p. 109; *T. olivacea, β T. botryoides* in Fries, Elench. 1, 1828, p. 198; *T. granosa,* Berk. & Curt. in Grevillea i., 1873, p. 149; *Zygodesmus bicolor* Cooke & Ellis, in Grevillea vii., 1878, p. 6.

Effused, separable, tissue very soft and loose. Subiculum and margin fibrillose or floccose, yellow-brown (ochraceous-tawny to Buchthorn-brown of Ridgway). Hymenium finely granular, fuscous, forming a delicate pellicle above the pale brown subiculum. Basidia clavate, with 4 sterigmata, 30-35 × 6μ. Spores angularly subglobose, aculeate, spore-body 6 × 5.5μ diam. Basal hyphae yellow-brown, 3-4μ in diameter, often united to form long slender strands.

Hab. On bark, Lyndhurst, Hants., Sept. 26, 1916; Carlisle, Sept., 1884 (in Herb. Kew sub *Zygodesmus fuscus*).

The species is easily recognised macroscopically by the granular hymenium and the contrast between its dark colour and that of the subiculum and margin. When a solution of potassium hydrate is added to microscopic preparations, an immediate blue-green colour is produced in the hymenium.

*Hypochnus cyaneus Wakef. sp. nov.

Sporophorum effusum, tenue, facile secedens, tomentosum, e cyaneo glaucescens, ambitu arachnoideo, concolore. Basidia elongato-clavata, 2-4-sterigmatica, hyalina, 30-40 × 7μ. Sporae cyaneo-tinctae, ellipticae, uno latere depressae, maturitate minute sparseque aculeatae 5-8 × 3-4μ. Hyphae basales leviter cyaneo-tinctae, hinc inde incrustatae, 1-3μ diametro, non nodosae.

Hab. On wet rotten coniferous log, Kew, Oct., 1911.

This plant is thinner and more vividly coloured than *Corticium caeruleum*. The colour is not uniform, but varies from "deep dull violaceous blue" through "Eton blue" to "glaucous green." After the specimens have been for some time in the herbarium, the blue colour fades to a dull greyish-green, or in parts yellow. A similar colour change appears to have taken place in herbarium specimens of "*Zygodesmus indigoferus* Ell. & Ev.," which however has smooth spores and is a *Corticium*. The present plant differs from these, and also from all other known blue species of *Corticium* and *Hypochnus* in its spores; these are coloured dull bluish, and are of the angular, warted *Hypochnus* type. The warts however are very small and give little more than an irregular outline to the spore.

The action of a dilute solution of potassium hydrate on the colouring matter appears to be very curious. In my notes taken from the fresh material I have the observation that the colour disappears from the spores and that the other parts turn greenish on the addition of this alkali to microscopic preparations. On examining the faded herbarium material, however, I find that potassium hydrate restores to the hyphae and spores a dull violet-blue colour, the reaction being similar to that of some spores to iodine. As I have only found the plant once I have been unable to confirm the behaviour in the fresh state. The hyphae at intervals show exudations of mineral matter, soluble in dilute hydrochloric acid.

**Hypochnus puniceus* (A. & S.) Sacc. Syll. vi., p. 661. *Corticium (Hypochnus) puniceum*, Fr. Hym. Eur., p. 661; *Thelephora punicea* Alb. et Schw. Consp.

Fung., p. 278; *Tomentella punicea,* Schroet. Pilz. Schles., i., p. 420.

Vaguely effused, very thin, with the habit of a Hyphomycete. Hymenium dull red, minutely granular, loose and pulverulent under the lens. Basidia 40-50 × 8μ, clavate, with 2-4 stout curved sterigmata, 5-8μ long, 2.5-3μ wide at the base. Spores subglobose, with short spines, dull reddish; sporebody 7.5-8μ in diameter, the whole with the spines 9-9.5μ. Subhymenial hyphae wavy and much branched, with clamp connections, 3.5-5μ in diameter, hyaline or pale coloured.

Hab. On decorticated pine wood, Beech Hill, Alderminster, Worcestershire. Coll. C. Rea, 26.7.16.

The spores of this specimen are slightly smaller than those described for the type, and resemble those of the sub-species *geophilus,* Sacc. It is therefore doubtful whether the latter is worthy of a separate name merely on account of its habitat.

**Hymenochaete cinnamomea* (Pers.) Bres. Hym. Kmet., p. 46. *Corticium cinnamomeum* Pers., Myc. Eur., i., p. 141; non *Coniophora cinnamomea* Mass.

Broadly effused, soft, and velvety in appearance. Spore-bearing hymenium cinnamon-brown, sterile portions darker (auburn); margin floccose, paler. Setae slender, subfusiform, sharply pointed, 60-80 × 4.5-6μ. Basidia 10-12 × 3.5μ, clavate, with 4 sterigmata, intermingled with long, cylindrical, blunt paraphyses, brown below, more or less hyaline above, 4μ in diameter. Spores hyaline or very slightly tinged straw-colour, cylindric-ellipsoid, curved, 5.5-6 × 2.5μ. Basal hyphae septate, without clamp-connections, loosely interwoven, 3μ in diameter.

Hab. On a fallen branch, Ilston Valley, Gower Peninsula, Sept. 13, 1916.

Distinguished from *H. corrugata* by the rich cinnamon-brown colour, softer texture, and microscopically by the slender setae, and the presence of paraphyses. The specimen gathered was very well developed, but the measurements of spores, setae, and hyphae as given above are slightly less than those usually described for typical *H. cinnamomea.* It appears to agree rather with Bresadola's form on *Corylus.* Unfortunately the identity of the host could not be ascertained.

**Corticium Galzini* Bourd. in Rev. sc. du Bourb. et du Centre, xxiii., 1910, p. 9.

Effused, forming a delicate pellicle loosely adherent to the substratum, whitish with a more or less glaucous or yellowish-green tint. Under the lens the hymenium appears loose and

pulverulent. Basidia borne in dense tufts, "candelabra"-fashion, 10-14 × 2-3μ, with 2-4 sterigmata. Spores obovate or narrowly elliptical, pointed at the base, 2-4 × 1-1.5μ. Basal hyphae loosely interwoven, septate, with clamp-connections, 2-5μ in diameter, usually 2-3μ.

Hab. Apparently always on coniferous wood. On rotten, wet, decorticated Spruce branches, New Forest, G. Massee, Mar., 1911; on decorticated coniferous wood, Byfleet, A. D. Cotton, Oct., 1911; on pine-cones, Weybridge, Oct., 1912; on rotten pine wood, Forres, A. D. Cotton, Sept., 1912.

The species is very near to *Corticium arachnoideum,* but is distinguished by the glaucous colour, the smaller spores, and the frequent clamp-connections. The determination was kindly confirmed by the Abbé H. Bourdot.

*Corticium coprophilum Wakef. sp. nov.

Sporophorum effusum, tenue, arachnoideum, griseo-albidum, facile secedens; hymenium pulverulentum. Basidia clavata, 3-6 sterigmatica, 15-25 × 6μ; sterigmata curvula, 2-5μ longa. Sporae subglobosae, 1-guttulatae, basi apiculatae, 4μ diametro. Hyphae basales 3.5-4μ diametro, vix septato-nodosae.

Hab. In fimo equino et in foliis caulibusque proximis, Kew.

This species was first met with during rather wet weather in July, 1912, growing on old horse-dung in a flower-bed, and spreading from the dung on to the surrounding debris. It was found again in August, 1916, on horse-dung in a field. The weather was very wet at the time, and the fungus was in excellent condition, spreading beyond the dung on to the surrounding grass-culms. The species is very delicate and evanescent, and can apparently only exist under very damp conditions.

In habit *C. coprophilum* somewhat resembles *C. Galzini,* but the spores are quite different. The habitat and the small globose spores are sufficient to distinguish it from other delicate Corticia of this type.

Corticium fastidiosum (Fr.) Bourd. in Bull. Soc. Myc. Fr., xxvii., 1911, p. 261. *Thelephora fastidiosa* Fr. Syst. Myc., i., p. 435.

This species grows on the ground, spreading for some distance over dead leaves, mosses, etc. The habit is not unlike that of *Sebacina incrustans,* but *C. fastidiosum* is distinguishable at sight by its opaque white, almost chalky appearance, and thinner, less fleshy texture. It is a true Corticium. Basidia clavate, 20-25 × 5-6μ. Spores hyaline, obovate, finely

echinulate, 6.5-7 × 4μ. Basal hyphae sparingly septate, 1.5-3μ in diameter, often incrusted with crystals.

Hab. On the ground in a mixed wood, Ilston Valley, Gower Peninsula, Sept., 1916.

Corticium fuciforme (Berk.) Wakef. comb. nov. *Isaria fuciformis* Berk. in Journ. Linn. Soc., xiii., 1873, p. 175; *I. graminiperda* Berk. & Muell. in Gard. Chron., 1873, p. 1596; *Hypochnus fuciformis* McAlp. in Ann. Myc., iv., 1906, p. 549; *Epithele fuciformis* v. Höhn. et Syd. in Ann. Myc., iv., 1906, p. 551.

In August, 1915, I was fortunate in finding material of this fungus which showed very well the fructification, first described by McAlpine. The filaments to which the name *Isaria* was given are usually merely sterile growths; they certainly do not produce conidia. The fertile portion of the fungus is a delicate effused, somewhat gelatinous incrustation, forming small patches here and there on the leaves and stalks of grasses. The spores are borne on typical basidia, each with four sterigmata, and the fungus is therefore a Hymenomycete. Basidia are also occasionally developed on the erect filaments. As explained already, the genus *Hypochnus* in the sense in which McAlpine used it is untenable. The fungus was transferred by von Höhnel and Sydow to *Epithele,* a genus superficially resembling *Odontia,* and distinguished from Corticium by the presence of sterile papillae projecting above the hymenium. While it is not a typical *Corticium,* it is at the same time not more closely related to *Epithele.* The outgrowths in this case are not apparently integral parts of the fructification, but are most developed where the hymenium is not formed. They may perhaps be compared with the mycelial cords which occur in many Thelephoraceae. As observed by McAlpine, they may resume growth at the tips on coming in contact with another blade of grass, and thus serve to bridge the space between one leaf and another. Their production is perhaps to be explained by the peculiar habitat of the fungus. For this reason I have preferred to refer the plant to Corticium.

Basidia slightly tinged pink, clavate, with 2-4 stout, curved sterigmata, 5.5-7μ in diameter above. Spores pip-shaped, one side depressed, hyaline, apiculate, 11-12.5 × 5-6μ. Hyphae tinged pink, with clamp-connections, thin-walled and rather vacuolate, 2-4μ in diameter. The walls of the hyphae are apparently slightly gelatinous, as they adhere very closely to any substance over which they may be growing, such as the sides of glass culture tubes. The fruit-body also has a slightly gelatinous consistency.

SOME CRITICAL REMARKS ON THE GENERIC POSITIONS OF PSATHYRA URTICAECOLA BERK. ET BROOME, COPRINUS PLICATILIS FR., AND PSATHYRELLA DISSEMINATA PERS.

By Professor A. H. Reginald Buller, D.Sc., Ph.D., F.R.S.C.

Introductory Remarks.—During the last ten years, I have made a series of investigations upon the structure and mode of functioning of the fruit-bodies of numerous species of the genus Coprinus. In 1909 in the first volume of my "Researches on Fungi," I gave an account of the mechanism for the production and liberation of spores in *Coprinus comatus*,* and in 1910 a similar account for *Coprinus atramentarius*.† In the latter, stress was placed on the function and fate of the cystidia. In 1911, I supplemented these studies with a communication on the production and liberation of spores in the genus Coprinus,‡ and then, in 1913, pointed out how the spore-producing mechanism of Bolbitius differs from that of Coprinus.§ A fortnight before the war broke out, I sent a fully illustrated paper called "The Production and Liberation of spores in *Coprinus sterquilinus*" to Germany for publication in Pfeffer's *Festschrift* (Volume LXVI of the *Jahrbücher für wissenschaftliche Botanik*). This paper, under the direction of Professor Klebs, was translated into German and published in the *Festschrift* in 1915.

By means of the investigations just indicated, I have gained a clear conception of the nature of the genus Coprinus and now feel in a position to decide whether or not any given Agaric should be regarded as a Coprinus.

* Longmans, Green and Co., London, pp. 196-215.

† The Function and Fate of the Cystidia of *Coprinus atramentarius*, together with some General Remarks on Coprinus Fruit-Bodies, Annals of Botany, Vol. XXIV., pp. 613-629.

‡ The Production and Liberation of Spores in the Genus Coprinus, Transactions of the British Mycological Society, Vol. III., 1911, pp. 348-350.

§ The Fruit-body Mechanism of Bolbitius, *ibid.*, Vol. IV., 1913, pp. 235-238.

The chief points in connection with the mechanism for the production and liberation of spores in the genus Coprinus are as follows:—

(1) The gills are very thin,
(2) The gills are parallel-sided or subparallel-sided,
(3) The gills are not positively geotropic,
(4) Usually the hymenium on one side of a gill at maturity looks slightly downwards and that on the other side slightly upwards,
(5) The spores ripen in succession from below upwards on each gill,
(6) The spores are discharged in succession from below upwards on each gill,
(7) Autodigestion proceeds from below upwards on each gill and removes those parts of the gills which become spore-free and which, if they continued in existence, would become mechanical hindrances to the fall of the remaining spores.

All the facts just given are correlated with one another. In the genus Coprinus the ripening and discharge of the spores from below upwards on each gill, and the autodigestion from below upwards on each gill, are special arrangements which permit of successful spore-discharge from parallel-sided, non-geotropic gills.

By contrast, the chief points in connection with the mechanism for the production and liberation of spores in non-Coprinus Agaricineae, such as the species of Amanita, Psalliota, Panaeolus, &c., are as follows:—

(1) The gills are sometimes very thin but are usually relatively thick,
(2) The gills are not parallel-sided but are more or less acutely wedge-shaped in cross-section,
(3) The gills are positively geotropic,
(4) Every part of the hymenium on any gill in a normally oriented fruit-body looks more or less downwards,
(5) The spores do not ripen in succession from below upwards on each gill but more or less uniformly all over the gill surfaces,
(6) The spores are not discharged in succession from below upwards on each gill, but more or less uniformly all over the gill surfaces.
(7) Autodigestion does not proceed from below upwards on each gill or involve any part of a gill during the period of spore-discharge.

In the light of these criteria, let us now consider the generic positions attributed to the three fungi named in the title of this paper.

Psathyra urticaecola Berk. et Broome.—Whilst hunting for fungi in Queen's Cottage Grounds at Kew Miss E. M. Wakefield and I found this species growing on sticks and other rubbish which had been dredged from the large lake in the Royal Gardens, and also on dead leaves and haulms of *Holcus lanatus* L. On one stick there were from twenty to thirty fruit-bodies which at the time were from one-quarter to one-third of an inch in height. At the Herbarium Mr. Massee at once recognised the fungus as *Psathyra urticaecola,* and this view was supported by other mycologists working there. The correctness of the identification is supported by the original description of the species as given by Berkeley and Broome,* which I find to be as follows :—

"*A.* (*Psathyra*) *urticaecola,* n.sp. Pileo campanulato, margine striato, stipiteque sursum attenuato, fistuloso, insititio flocculentis albis; lamellis antice ventricosis, postice attenuatis, ex albo spadiceis.

On nettle-roots. King's Cliffe, Aug. 8, 1858.

Pileus 2 lines across, campanulate, flocculent, white; margin at length straight, striate; stem short, slender, attenuated upwards, flocculent, fistulose, springing immediately from the matrix; gills ventricose in front, attenuated behind, adnexed, at first white, then a rich chocolate.

Allied to *A. pennatus.*"

The specimens which Berkeley and Broome deposited in the Kew Herbarium are so shrivelled that they were found to be of little or no value in assisting identification of the living fungi; but it was noted that Berkeley had added a note upon the specimen sheet, which contained a description of the species in English similar to that just quoted and also the following additional remark :—

"Allied to *A. pennatus* but gills by no means black; habit of a Coprinus or *A. sericellus.*" Finally, there was a pencil note on the sheet showing an oval spore and a description of the spores as "brown with a very slight purple tinge."

The King's Cliffe specimens are illustrated in Plate 596 of Cooke's *Illustrations of British Fungi,* and the size of the spores is there given as $7 \times 4\mu$.

From the above description, notes, and illustrations, I was able to convince myself that the fungus which I had collected at Kew was identical with *Psathyra urticaecola* Berk. et Broome.

I discovered that the supposed Psathyra is in reality a Coprinus. The sticks on which the young fruit-bodies were

* Berkeley and Broome, Notices of British Fungi, Ann. and Mag. of Nat. Hist., May and June, 1861.

growing were placed in a damp chamber. The fruit-bodies underwent autodigestion in the following night. Several other crops of fruit-bodies subsequently came up, and each of them shed their spores and became reduced by autodigestion in the night. On examining the fruit-bodies with the microscope, I found that all the seven criteria already given for the genus Coprinus were satisfied. The gills of the pileus are (1) exceedingly thin, for they scarcely exceed 0.1mm. in thickness, (2) parallel-sided, and (3) non-geotropic, for they are held together in a solid mass in the same way as in *Coprinus atramentarius*. Since the gills are parallel-sided, non-geotropic, and closely packed, it must of necessity happen that (4) one side of a gill looks slightly upwards and the other slightly downwards. The spores were observed (5) to ripen and (6) be discharged from below upwards on each gill; and, finally (7), typical coprinoid autodigestion was seen to take place: the gills were gradually destroyed from below upwards, the spore-free portion being liquefied and thus gradually removed out of the way of the falling spores.

As we have seen, Berkeley remarked on the Kew herbarium sheet that *Psathyra urticaecola* has "the habit of a Coprinus." The reason why Berkeley and Broome failed to discover that this fungus is a Coprinus and not a Psathyra is probably because the autodigestion of the gills takes place at night. I found that the gills are white in the morning but turn chocolate from below upwards with the ripening of the spores during the afternoon, and that spore-discharge takes place in the evening and night. By the following morning the fruit-bodies are exhausted and falling.

The spores, like those of several other very small species of Coprinus, are not jet black but distinctly chocolate-coloured. They measure $7 \times 4\mu$ and are oval. The top of the pileus is chalky white and beset with flocculent masses of matted hyphae. The cystidia are cylindrical-oval and are firmly fixed by both ends into opposing gills which they bridge as in *Coprinus atramentarius*. The basidia are dimorphic as is usual for Coprini; but the long and short basidia are rather freely spaced. The paraphyses are distinctly pedicellate.

The following description may now be given of the fungus:—

Coprinus urticaecola (Berk. et Broome) Buller, new combination. Pileus about 5 mm. in diameter in the hemisperical condition, almost spherical at first, becoming hemispherical at the time the spores begin to ripen, opening out and even becoming revolute and radially split during the discharge of the spores, chalky white, unstriate, beset with numerous small white scales composed of matted hyphae

unmixed with globular cells and not bearing crystals of calcium oxalate. Gills very thin, about 0.1—0.15mm. thick, ventricose, maximum width 1.5 mm., at first white then becoming chocolate, the colouration proceeding from below upwards, held together by cylindrical-ovate cystidia which cross the interlamellar spaces as in *Coprinus atramentarius* and undergo complete autodigestion in the evening and night. Stipe when fully elongated 1.5-2 cm. high, 2 mm. thick below, attenuated upwards, scarcely more than 1 mm. thick at the top, white, flocculent at the very base otherwise smooth, when pulled from the wood to which it is attached leaves a small discoid piece of itself behind, hollow. Spores minute, $7 \times 4\mu$, oval, smooth. Spore-discharge and autodigestion of the gills take place in the evening and night.

On sticks, also on dead leaves and haulms of a grass (*Holcus lanatus* L), Queen's Cottage Grounds, Kew, June, 1912.

Coprinus plicatilis Pers. Massee,* in 1906, stated that "Many species included in Coprinus, as *C. plicatilis* and others having dry non-deliquescent gills, have no real affinity with this genus;" and on mycological excursions I have heard the suggestion put forward that *C. plicatilis* is rather a Psathyrella than a Coprinus. The true generic position of this fungus therefore appears to be a matter of some doubt.

For a number of years I have had excellent opportunities for examining the structure and mode of spore-discharge of the species in question. I find that all the seven criteria for a Coprinus are satisfied except one: there is no autodigestion of the gills from below upwards. The gills are (1) very thin, for they are not more than 0.15mm. thick, (2) parallel-sided, and (3) non-geotropic, a fact decided by experiment. Since the gills are parallel-sided and non-geotropic, it must of necessity happen that (4) one side of a gill looks slightly upwards and the other slightly downwards. I have convinced myself that (5) the spores ripen in succession from below upwards on each gill and that (6) the spores are discharged in succession from below upwards on each gill; but microscopical as well as macroscopical examination shows that autodigestion does not proceed from below upwards on each gill. Massee truly described the gills as being dry and non-deliquescent.

I regard *Coprinus plicatilis* as a Coprinus which has lost one of its chief Coprinus characters, namely, autodigestion; but I do not hesitate to retain the fungus in the genus

* G. Massee, Text-Book of Fungi, London, 1906, p. 364.

Coprinus, because with this exception all the characters are coprinoid. In no other genus than Coprinus do the spores ripen and become discharged from below upwards on the gills.

The basidia are trimorphic as a rule, but here and there on a gill they may be dimorphic. The long and short basidia, together with the pavement-like paraphyses, have the normal coprinoid arrangement. The zones of spore-discharge are unusually wide but they nevertheless proceed from below upwards on each gill. The loss of autodigestion is doubtless associated with the fact that as the pileus opens it becomes spread out like a parasol. The gills split along their median planes from above downwards and thus become **Y**-shaped in vertical transverse section. The upper parts of the gills thus come to look downwards and the spores there discharged can escape freely from the pileus without any danger of striking an obstacle. It is noticeable, however, that one side of the unsplit lower portion of a gill is often powdered black with spores which have failed to gain their freedom. This appears to be due to the fact that the side so powdered has looked slightly upwards and has therefore caught the spores on its surface after they have been shot away from its hymenium and have fallen vertically for a certain distance. The loss of autodigestion is therefore associated with a certain loss of efficiency in spore-discharge.

In certain other small Coprini, *e.g.*, *Coprinus ephemerus* Fr., the pileus also opens out parasol-wise before spore-discharge begins and each gill becomes **Y**-shaped in cross-section. However, in all these species the lower part of the vertical portion of each gill distinctly undergoes autodigestion which can be observed either with the eye or with the microscope, so that in these cases the most characteristic feature of the mechanism of Coprinus fruit-bodies has not been eliminated. My investigations upon numerous small species of the genus Coprinus have convinced me that *Coprinus plicatilis* alone has lost the power of reducing its gills by autodigestion during spore-discharge; and I therefore cannot agree with Massee when he states that *many* species included in the genus Coprinus have dry and non-deliquescent gills.

There is a fungus which has come up spontaneously on horse-dung several times in my laboratory at Winnipeg. It so much resembles the *Coprinus plicatilis* which occurs in such abundance in grassy fields in England, that at first I thought that the two species were identical; but a careful comparison has convinced me that they are distinct. The two fungi are similar in their brownish colour when young, in their umbonate disc becoming depressed at maturity, in

the collar formed by the inner ends of the gills around the top of the stipe, and in the black colour, almost identical size, and the shape of the spores. However, the Winnipeg species differs from *Coprinus plicatilis* in having (1) a somewhat browner pileus in the expanded condition, in (2) having a somewhat longer stipe relatively to the breadth of the pileus, in (3) growing on horse-dung instead of on grassy turf, but especially in (4) the fact that the lower portion of the vertical part of each gill undergoes a slight but quite definite amount of autodigestion from below upwards during the period of spore-discharge. The Winnipeg species which may be new and as yet undescribed, is evidently a Coprinus, and it serves to connect *Coprinus plicatilis* with the more typical Coprini, such as *Coprinus fimetarius, C. niveus* and others in which autodigestion of the gills from below upwards is a very obvious and striking character.

Psathyrella disseminata Pers. Lange has recently published a monograph on the genus Coprinus in which he has described in detail thirty-three species which have been found growing in Denmark.* In his section *Nudi,* he includes two fungi which Fries regarded as Psathyrellae, namely, *Coprinus disseminatus* (Pers.) Quél., which Fries called *Psathyrella disseminata,* and *Coprinus impatiens* (Fr.) Quél., which Fries called *Psathyrella impatiens.* The latter species I have not so far had an opportunity of examining but to the former I have paid considerable attention. Every field mycologist knows that this fungus often comes up by hundreds in autumn upon and around old tree stumps.

I have no doubt whatever that Lange is in error in placing *Psathyrella disseminata* in the genus Coprinus. If one examines the gills carefully with the microscope, one finds that they satisfy the seven criteria for a non-Coprinus, lamellate fungus, possibly with the exception of the third. The gills are (1) thin but (2) they are acutely wedge-shaped in cross-section. Whether or not they are (3) positively geotropic I do not know. However, every part of the hymenium on any gill in a normally oriented fruit-body looks more or less downwards, for the stipe, by means of a very precise negative geotropic reaction brings the median planes of all the gills into approximately vertical positions. The most important criteria are the fifth, sixth, and seventh. The spores (5) do not ripen in succession from below upwards on each gill but more or less uniformly all over the gill surfaces.

* Jakob E. Lange, Studies in the Agarics of Denmark, Dansk Botanisk Arkiv udgivet af Dansk Botanisk Forening, Part II., No. 3, 1915, pp. 46-47.

The spores (6) are not discharged in succession from below upwards on each gill but more or less uniformly all over the gill surfaces. Finally (7), autodigestion does not proceed from below upwards on each gill or involve any part of a gill during the period of spore-discharge. The collapse of the gill and pileus as a whole takes place only when spore-discharge has ceased. *Psathyrella disseminata* is therefore not a Coprinus; and, for the present at least, there is no good reason for changing its generic position from that given to it by Fries.

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